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COL. BANGE'S ARTILLERY SYSTEM.*

When, after our disasters, it became necessary to reorganize our field artillery, it was deemed indispensable to adopt only a *matériel* that should possess great and undisputed superiority over the best foreign pieces. It was in such a direction that the Tarbes, Bourges, and Calais Commissions received an order to direct their study, and to establish the data of the problem, which they did in the year 1873.

Field artillery must, according to the terms of the regulations, open the battle, cover the deployments of the troops, prepare for the decisive attack by close firing, concur in a special manner in certain details of the fight, and aid in the pursuit of the vanquished foe. It must, then, possess great mobility in order to be able to follow, and sometimes, even, precede the infantry or cavalry. It follows from this that its *materiel* necessarily excludes pieces of large caliber.

On another hand, it is its duty to hold and occupy the enemy by keeping up an action at distances that cannot be reached by portable firearms, to fight the enemy's artillery, to protect retreats, and to pursue the vanquished foe alone when there is occasion therefor, due to the unevenness of the country proving an obstacle to the co-operation of the other branches of the service. It is necessary, therefore, that its *materiel* shall have great power and range, and this implies the exclusion of pieces of small caliber.

In order to properly fill the role that devolves upon it, but especially to prepare the attack by its close firings, it is called upon to produce, at certain moments and at certain points, effects that are deadly and irresistible. Hence it follows that its aim must be capable of being made with accuracy and rapidity.

Finally, it is necessary that the field *materiel* shall have sufficient endurance, and that it shall include but a limited number of calibers. Were it not, in fact, sufficiently strong, it would soon be out of service and thenceforward prove more embarrassing than useful. A diversity of calibers would be accompanied with a diversity in ammunition, and this would introduce into the difficult problem of supplying the batteries, a complication which would not always be without danger.

Such are, in brief, the multiple conditions that good field ordnance must fulfill. The qualities that it must combine are, as may be seen, very diverse, and sometimes contradictory and difficult to reconcile; and the committees on experiments did not fail to recall them to the officers who were to devote themselves to a study of the question.

On another hand, various technical difficulties arose in the way of the officers to whom the question was submitted. It had for a long time been demonstrated that spherical projectiles thrown by smooth guns could possess no accuracy; that, as regards preservation of velocity, oblong projectiles are much superior to spherical ones; that an initial rotation around an axis directed according to the line of aim secures to an oblong projectile a regular motion in the air, and that for this reason it is well to give oblong projectiles a cylindro-ogivoid form in which the height of the ogive shall be equal to triple the radius of the base. It was known that such rotation could be obtained by means of helicoidal grooves in the barrel of the gun; that it was necessary to have recourse to the use of that kind of rifling called "progressive," in which the pitch of the directing helix progressively diminishes from the chamber to the muzzle; and that in the system of loading by breech the projectile is forced into the rifling and is thus given greater range and accuracy. The majority of these facts were known to the investigators who were called upon to take part in the competition that had just opened in France.

Colonel Bange, who was then an artillery officer, was one of those who devoted themselves to a rational solution of the problem that had been proposed, and it was not long before he presented two types of cannon—one of them of 90 mm. caliber and the other of 80. Having, in the course of the first experiments, given the most satisfactory results, these two pieces were placed upon trial among the troops, and definitely adopted January 23, 1877. At present all the mounted batteries of the army are uniformly armed with

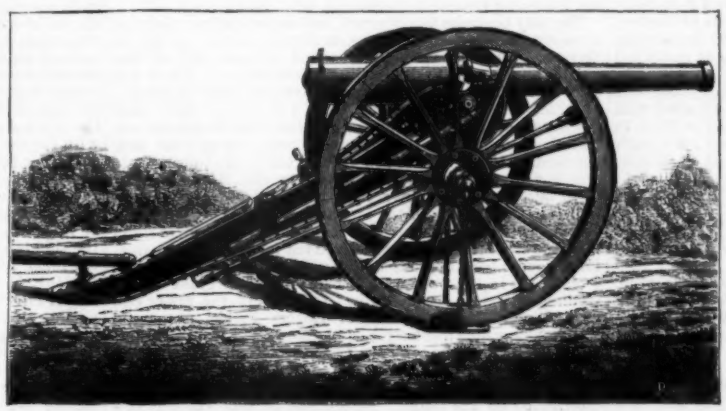


FIG. 1.—BANGE FIELD PIECE OF 90 MM. CALIBER.

90 mm. cannon, while all the horse batteries are provided with those of 80 mm.

The Bange 90 mm. gun is a steel straight-rifled (24 progressive grooves) piece, and loads at the breech. Its mean weight is 530 kilogrammes, and, with a normal charge of 1,900 grammes of powder, it throws an 8 kilogramme shell with an initial velocity of 455 meters. The maximum range

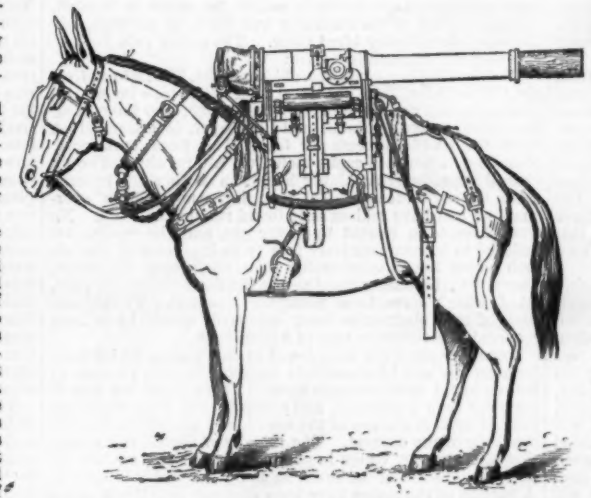


FIG. 4.—MOUNTAIN GUN CARRIED BY A MULE.

is about 8 kilometers. The barrel of the gun (Fig. 1) is a cast steel, hammered, and bored tube, tempered in oil and strengthened with six hoops at the breech. The breech mechanism consists of a steel screw, having threads thrice interrupted, carried by a hand wheel which is movable around a hinge placed to the left of the breech hoop. This screw is capable of entering a nut (having likewise thrice interrupted threads) which is formed in the metal itself and which is called a breech recess.

It is easy to see how the mechanism works.

In order to prevent the escape of any gas in the direction of those who maneuver the piece, the breech screw is provided in front with a special apparatus called the Bange obturator, which consists of a cake of asbestos saturated with mutton suet. This plastic material is inclosed in a linen wrapper which is protected, in front and behind, by two tin cupels.

The 90 mm. cannon throws three kinds of projectiles, viz., the ordinary shell, the ball shell, and canister shot.

The ordinary shell is a hollow cast iron projectile of cylindro-ogivoid form with a flattened head, containing an aperture for the introduction of the powder. This aperture, after the shell has been charged, is closed by screwing a fuse into it. At its lower part the shell carries, set into it, a copper band which is turned cylindrically to a diameter slightly greater than that of the bore of the piece at the extremity of the rifling. The object of this appendage will be presently seen. When empty, the shell weighs 7·5 kilogrammes, and it has an internal capacity for 300 grammes of powder. It is provided with a campaign percussion fuse of the Budin type. Thus charged and primed, its weight is 8 kilogrammes.

The ball shell (model of 1879) has the same form and dimensions as the preceding. It consists of an iron shell cast over a cast iron core formed of twelve crowns of balls or cylinders—92 balls or cylinders in all. The charge is 200 grammes of powder. Thus charged, and provided with a double-acting 25 mm. fuse, the ball shell weighs, on an average, 8·15 kilos. The canister consists of a zinc cylinder containing 123 hard lead balls, each weighing 44 grammes. These balls, which have previously been covered with grease, are arranged methodically in successive layers and are kept in place by pouring melted brimstone around them. Thus arranged, a canister shot for a 90 mm. gun weighs 7·8 kilos.

In ordinary campaign firing, whatever be the projectile to be thrown, only a single charge of powder weighing 1·9 kilos is used. This charge is enclosed in an amiantine cloth bag—an incombustible material made of silk waste.

And now as to the mode of firing and what occurs in the chamber. When the shell is in place in the gun, the front edge of its copper girdle rests against the side of the truncated cone that connects the projectile chamber with the powder chamber. As soon as the projectile is set in motion by the explosion of the powder, its ring, upon entering the rifled part of the gun, is cut by the steel of the projections at the bottom of the barrel, and all the space around the ball is thus completely filled. Guided by the intervals between the grooves, which enter its copper ring, the projectile can only move forward by revolving. It therefore necessarily takes a rotary motion around its axis in the bore, and preserves such motion on issuing from the muzzle. From this moment its travel through the air is a regular one.

The Bange 80 mm. gun is a straight-rifled (24 progressive grooves) steel piece that loads at the breech. This weapon, which has a mean weight of 425 kilos, throws, with a normal charge of 1,500 grammes, a 5·5 kilogramme projectile whose initial velocity is 490 meters, and whose maximum range is about 8 kilometers. The cannon differs from the one just described only in dimensions. Like that, it throws three kinds of projectiles—the shell, ball shell, and canister. The ordinary shell weighs, when empty, 5·1 kilos. It holds 240 grammes of powder and is primed with a Budin percussion fuse. Thus charged and primed its weight is 5·5 kilos. The style of the ball shell has not yet been decided upon. As for the canister, that is in all respects like the one just described, and differs from it only in dimensions. It contains 85 hard lead balls, and its mean weight is 5·5 kilos. Whatever be the projectile to be thrown, the charge of powder is in all cases 1·5 kilos.

* By Maj. De Sarrepont, in *La Nature*.

FIG. 2.—BANGE FIELD PIECE OF 80 MM. CALIBER.

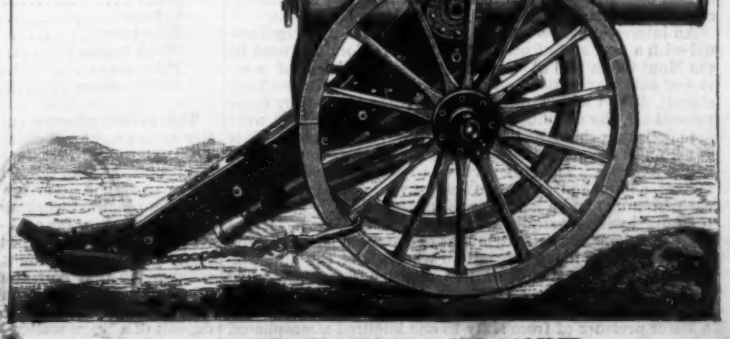


FIG. 3.—MOUNTAIN GUN OF 80 MM. CALIBER.

Mountain Artillery.—In hilly countries, and in regions where no made roads are met with, the artillery *materiel* that can be used must be, for easy carriage, as light as possible Thirty years ago we used for this purpose a bronze 12 centimeter howitzer, which was very light and which threw, with a small charge, a 4 kilogramme shell that contained 280 grammes of powder, and that had a range of from 600 to 800 meters. After this there was put in service a rifled 86 mm. caliber mountain gun made of bronze, which threw, with a charge of 300 grammes, a 4 kilo projectile having a range of 2,000 meters. This gun was discarded in 1858.

The Bange 80 mm. mountain gun (Fig. 9) is a steel breech-loader with straight rifling (24 progressive grooves). It has a mean weight of 105 kilos, and throws, with a normal charge of 400 grammes of powder, a projectile that weighs 5·6 kilos and has a maximum range of about 5 kilometers. It was adopted and put in service by an official decision of the 25th of July, 1878.

The barrel of this gun is of cast, hammered, bored steel tempered in oil. Its breech is strengthened by five hoops or bands of puddled and tempered steel. The breech mechanism is nearly the same as that of the field piece of 90 mm., only reduced in size.

The piece throws identically the same projectiles as the latter, except that the ordinary shell is primed with a fuse called a mountain siege-percussion cap. Whatever be the projectile the charge of powder is always 400 grammes, inclosed in an amiantine cloth bag. As it has to pass through narrow defiles, as well as over rough and dangerous roads, it is usually carried on the backs of beasts of burden. We have chosen the mule for this purpose, as he is a strong, mild animal who does not mind heat, and who is easily fed and yet particular in his choice of water. He is rarely sick, but the affections that he is subject to are dangerous and often mortal. He can, when in good health, be loaded with from 100 to 150 kilogrammes, but it is well, in the field, to observe the lower limit. The cannon is carried on a pack saddle as shown in Fig. 4. The ammunition is packed in long boxes, each containing eight projectiles and eight charges. Each mule carries on each side of his saddle two of these boxes, weighing together about 120 kilogrammes. Shafts may be attached to the gun-carriage so that it can be hauled by a horse. But this mode of transportation is only exceptionally employed.

A mountain battery comprises six gun mules, six carriage mules, six wheel mules (with shafts), twenty-four ammunition case mules, one mountain forge, and three artillery wagons with reserve ammunition.

Colonel Bange's breech mechanism is put together and taken apart without tools, and it is so easy of management that it might be confided to the hand of a child. It takes but one gunner, moreover, to maneuver each gun, and this man has no need of an aid in successively loading, aiming, and firing the piece. As for the ingenious obturator that we have spoken of, that is simply a *chef-d'œuvre.*

THE ARLBERG TUNNEL.

THE boring of the tunnel through the Arlberg (the Eagle's Mount), a branch of the Rhætian Alps, has been completed.

The Arlberg Tunnel ranks only after the Mont Cenis and Mount St. Gothard tunnels among great modern engineering works of its class in Europe. The object of the new line is to shorten the distance between Western Austria and Eastern Switzerland, create a direct traffic between the two countries, and render them independent of the South German railways over which it has been heretofore conducted. The new line is divided into two sections—the first running from Innsbruck to Landeck, the second from Landeck to Bludenz. The former, which is forty-five miles in length, passes along the right bank of the Inn. Its construction presents no extraordinary engineering difficulties. The construction of the stretch between Landeck and Bludenz has been much more difficult and costly. It is a mountain line from first to last. In the Valley of Rosanna the gradient is one in forty. The road crosses the Valley of Panznau on a viaduct of three arches, each having a span of 197 feet. The length of this stretch is thirty-five miles, and the total estimated cost 11,784,000 florins, or $5,892,000.

At St. Antoine, 1,721 feet above Landeck, is the beginning of the great tunnel, on which work has just been completed. The point fixed upon by the Austrian Government for commencing this work is not the one that was chosen by Gen. Nordling, who first surveyed the ground. The tunnel, had his scheme been adopted, would have been higher up the mountain, shorter, wide enough only for single rails, and, therefore, less expensive than the one finally fixed upon. But the Government, believing that the Arlberg Line will some day be one of the most important in Europe, decided that it was expedient to provide every facility for a great traffic. The gradients were made as easy as possible, even though the tunnel should be a little longer, and the line will be double-railed throughout its length.

The work of boring the tunnel began on the Austrian side in June, 1883, and in September operations were begun on the Swiss side of the mountain. The work proceeded at a speed which affords a striking illustration of the improvements that have lately been effected in the art of mountain tunneling. The Mont Cenis Tunnel was bored at the rate of 3,537 feet a year, the St. Gothard at the rate of 5,474 feet, and the Arlberg was pierced at the rate of 7,080 feet a year. The Arlberg engineers also profited by the experiences of their predecessors in the matter of cost, for while the outlay on the Mont Cenis Tunnel was $2,000 per running meter—thirty-nine and one-half inches—and on the St. Gothard $1,250, the expense of making the Arlberg did not exceed $750 to the meter. In this regard, however, the tunnel last named benefited by its shortness, since the longer the tunnel, other things being equal, the greater is its relative cost.

An interesting experiment was made in the Arlberg Tunnel with a new sort of perforator. The perforators used in the Mont Cenis and St. Gothard tunnels consisted of a series of chisels (not diamond pointed, as has sometimes been stated), driven with a quick, hammer-like action by compressed air, the machines for the production of which were actuated by turbines at the two ends of the galleries. This system was the one in use on the eastern, or Austrian, side of the Arlberg. The chisels cover a space of seven square meters, and make twenty to twenty-five holes at one time, each from one and a half to two meters deep. These are then filled with dynamite and the mine exploded. Every blast lengthens the drift by about one and a quarter meters. The perforators move forward on wheels, and the air, compressed to a pressure of five atmospheres, is supplied through flexible tubes. On the west side drills are employed of a diameter of seventy millimeters, to which, by means of a water pressure of from sixty to one hundred atmospheres, a rotary movement is communicated. Six or eight of these drills are as effective as twenty or twenty-five of the atmospheric perforators, and the holes they make are so much wider that equal results are produced with lighter charges of dynamite.

The greatest difficulty in Alpine tunneling consists less in quarrying out a passage than in getting rid of rubbish. After every blast the outcome of it, in the shape of loose material, must be removed before boring operations can be resumed; and when an atmosphere already close and impure is still further fouled by the smoke of an explosion, the labor of removal becomes dangerous as well as difficult. Fatal accidents sometimes happen. The leading miners in the Arlberg Tunnel, when engaged in this work, cover their mouths and nostrils with sponges which have been steeped in vinegar, an expedient which has been found singularly efficacious in neutralizing the bad effects of the poisonous air they are often compelled to breathe. The important part which the removal of rubbish plays in these undertakings is shown in the fact that of the time required for the making of the Arlberg Tunnel fully one-half was devoted to the carrying away of loose material.—*N. Y. Herald.*

SEWERAGE SYSTEM OF MEMPHIS.

SINCE the adoption of the Waring system of sewerage, the the city of Memphis is one of the best drained cities in the United States. From the reports and exhibits of Maj. Niles Meriwether, engineer in charge of sewers, we gather the following interesting information:

The city occupies the summits and slopes on both sides of a valley, which is drained by a stream known as Bayou Gayoso. The main sewers are located on each side of the bayou, and as near to it as found practicable. There are altogether about thirty-eight and six-tenths miles of sewers, of which four miles are mains, located along the bayou, and discharging into the river by one outlet; the remainder are laterals, draining into these mains, except about four and one-tenth miles of sewers constructed before the present system was adopted, and discharging into the Mississippi by other outlets. The mains are ten, twelve, fifteen, and twenty inches in diameter. Of the laterals, about 85 per cent. are six inches in diameter, and the remainder eight inches, except a few short lengths, which are ten inches. The mains, for the most part, are laid with a grade of two inches in 100 feet, which is the minimum. The minimum grade of the six inch laterals is six inches in 100 feet. At the upper end of each lateral is located one of Rogers Fields' automatic flush tanks, which discharges one hundred and twelve gallons in about forty seconds. This tank discharges its contents as often as it is filled, but it is considered that once in twenty-four hours is sufficient. The system is with manholes freely distributed on the mains. No surface or roof-water is permitted to enter the sewers, the system being designed and proportioned for house sewerage only. The house drains are all four inches in diameter, and no trap is permitted on the main drain, each fixture being provided with a separate trap. The soil pipes are of cast iron with lead joints above the ground, and extend four inches in diameter above the roof. Each house drain is consequently a ventilator for the public sewer. For the purpose of removing the subsoil water, agricultural drain tiles are laid in the trench with each lateral on the grade of the sewer, or below it, which discharge, not into the sewers, but into the bayou. Additional lines of tile have been laid in the streets in which no sewer is located. A large portion of the trenching was done by contract, but the pipes were laid by hired labor. The prices paid for excavating and brick filling were:

Trenches 6½ feet deep, 25c.; 6½ to 9 feet, 30c.; 9 to 12 feet, 45c.; 12 to 15 feet, 75c. per lineal foot. The pipe laying, including laying drain tile in the same trench, also the cost of the cement, sand, oakum, and tile paper, is estimated at seven and six-tenths cents per foot. The flush tanks cost, completed, about $45 each, including $10 royalty. The six inch pipes, although draining houses on both sides in some cases for a distance of 3,000 feet, have never been overcharged, and have seldom been found running half full. No trouble has been caused by sewer gas, and the sewers are believed to be comparatively free from it. Some of the six inch pipes have occasionally been obstructed by sticks, bones, etc., becoming fixed across the diameter of the pipe, all of which have been promptly removed. Twenty-one cases of such obstruction have occurred, which have been removed at an average cost of $13.50 each.

Some deposits have been found in the mains, which have been rapidly and inexpensively removed by the passage of hollow metal balls through them. These balls are less in diameter than the sewers, and being lighter than water are pressed against the top of the sewer, and are rolled along by the force of the current. The velocity of the ball is less than that of the water, which in passing it is deflected against the bottom and sides of the sewer so as to thoroughly cleanse it. A portion of the mains have been cleansed four times since their construction; the laterals not at all. Pipe laying was commenced about the 20th of January, 1880, and on July 1st, of the same year, about twenty miles had been laid. The first house connections were made about the 1st of March of the same year. On the 13th of June, 1883, hourly observations showed the greatest depth of flow fourteen inches, at 11 A. M.; least depth, ten and one fourth inches, at 4 A. M. Floats in the same sewer gave a surface velocity of two and six-tenths feet per second, the depth being twelve and one-fourth inches.

The following is a statement of the connections made with this system, but does not include those made with the old sewers, discharging by other outlets:

Water closets	4,715
Sinks	3,224
Urinals	179
Bath tubs	334
Wash basins	308
Privy sinks	84
Cellar drains	24

This system of sewers gives entire satisfaction both to the city government and citizens generally.

Dr. Thornton, President of the Board of Health, in his last report, has the following to say of the workings of the sewerage system described above:

"The practical working of the sewer is giving entire satisfaction, and, as far as I know, fully answering the ends claimed for it by its projector. The chief advantages of this system over the ordinary sewers of other cities are the economy in first cost, the prevention of sewer gas to its minimum, the exclusion of storm or surface water, and their facility in cleansing themselves, or in the prevention of the deposit of sewage matter in any portion of the pipe. The periodical flushing by an automatic arrangement of a flush tank, placed at the head of each lateral six inch pipe, when it discharges, cleanses the pipe of all deposit, should there be any, thereby preventing any decomposition in the sewer."—*Journal.*

SINKING THROUGH QUICKSAND.

MR. RITSON WILSON has given a description of the difficulties encountered in sinking through quicksand at the Minnie Pit, Podmore Hall Colliery, Audley, in a paper read before the North Staffordshire Institute of Mining and Mechanical Engineers, at Stoke-upon-Trent. The boring was done to a depth of 70 feet, the first 38 feet of which was quicksand highly charged with water, having only a surface soil of 2 feet. Wrought-iron pipes were provided to secure the bore-hole through the quicksand section, the pipes being made with screw-joints. The tubbing was made of cast-iron, in segments, about 7 feet long, 3 feet deep, and 1 inch thick, the bearing width being 5 inches. The finished diameter of the pit was 18 feet. The external part of the tubbing was made with a smooth back suitable for sliding, the flanges all being cast on the inner side. The seams and flanges were all arranged to admit ¼-inch pitch pine sheeting, which was put in as each ring of tubbing was put on, and was therefore ready for wedging as soon as the tubbing was once bedded. The flange seams were all assisted by internal ribs and bracket stays, to resist the strain the process of wedging put upon them. In each segment there were corresponding bolt holes for the purpose of bolting the rings of tubbing together while the tubbing was sliding; and when the tubbing was bedded, the bolts that strapped the respective rings together were removed, and the holes tightly wedged up by pitch-pine plugs. This was done in order to dam all the water back, and proved satisfactory. The tubbing was so arranged that, when solid ground was reached with the foot of the tubbing, the same might be safely rested and the sinking proceeded with until suitable ground was met with for the wedging bed being laid. The bed being complete, the tubbing was brought up from the bed in the usual way and joined to the tubbing temporarily rested. This enabled a good dry bed to be taken, as all water at the foot of the rested tubbing was gathered with a temporary garland or ring. It was also advisable to so arrange the flanges of the tubbing that masonry could afterward be built flush by the inner edge of the tubbing, which not only prevented the tubbing from corroding, but would prevent anything that might fall down the pit from breaking the flanges off. The arrangements for hanging the tubbing were as follows:

To the eight screw bolts hanging rods were connected and brought down the face of the tubbing and coupled to links attached to the eyes or loopholes cast on the low ring of the tubbing for the purpose. The sinking began in April last. Before beginning to sink, three rings or three yards of tubbing were bolted together and hung to center line and level by the hanging bolts. Sinking was begun with nine men to each shift, and as each few inches of pit bottom were dug out, the tubbing was lowered in by the screws, and when a depth of 4 feet was reached, the water began to come in at the pit bottom at the rate of 70 gallons per minute. This, however, did not interfere with the speed of the sinking much till a depth of 9 feet was reached. Then it was found that the ground was beginning to subside for a considerable distance all round the pit mouth, and the sand in the pit bottom began to lift freely 3 feet above the nose of the cutting curve. After working for two hours the lifting in the bottom considerably abated, and it was possible to make good headway till the sixth yard was reached, when the bottom began to make water at the rate of 140 gallons per minute. The surface all around the pit gradually sank, but the subsidence was made good by ashes and other loose material. When the tubbing reached the clay section, the tubbing sank more freely on one side than on the other. The hanging rods were brought into requisition, but were broken. They were, however, caught up by ropes attached to them and prevented from falling upon the men. The tubbing got 8 inches out of plumb. To restore it to a straight position, the clay bed on one side had to be undermined. Afterward, the marl on one side of the pit was thicker and stronger than on the other side. The tubbing began to wrench, and three rings of it were broken through. This wrenching was checked by driving some legs under the first flange of the tubbing, which made a temporary foundation sufficiently strong. Wrought iron plates were afterward screwed across the cracks of the broken segments. Soon after starting again, three other rings or segments broke, and the strengthening of these was done in the same manner as the others had been before.

The idea of sliding the tubbing any farther was abandoned. This necessitated securing the deep side of the pit by spiling, and the sinking was proceeded with at a reduced diameter, or 16 feet 3 inches finished. To maintain the safety of the foot of the tubbing inside the spiling, a second length of sliding tubbing was arranged and made 16 feet 3 inches in diameter inside. Three lengths of this tubbing were put in, which reached to center and level, and the space between the outer and inner rings of tubbing secured with concrete and wedging. Then the sinking went on in the usual way, and as each length of sinking was done, a ring of tubbing was bolted on to the lower end of the inset tubbing, which remained a fixture, being secured by legs in the pit bottom and held by the wedging as between the rings. This was repeated for the first six yards below the sand. Then a wedging curve bed was bored for, and by the boring suitable ground was proved to lie about 4 yards down from the foot of the last tubbing ring, or about 10 yards below the foot of the sand. The wedging bed was made of solid cast iron, 18 inches by 5 inches, with two escape valves, and securely wedged. Then from this bed the tubbing was brought up in the ordinary way, and jointed to the tubbing hung below the foot of the sand. This tubbing had been wedged, and made the pit altogether down through the sand sections secure. The first 11 yards of the quicksand sinking were accomplished in nine days. After that the men were engaged several days in strengthening the broken segments and securing the foot of the top length of tubbing. Since the wedging referred to, the sinking has altogether gone on very favorably, and is now averaging from 7 to 8 yards per week finished pit. During the quicksand sinking, there was a flow of water of about 170 gallons per minute, which was disposed of chiefly by a pulsometer pump.

THE railroad track on the new bridge between Minneapolis and St. Paul—the only stone bridge over the Mississippi—is sixty feet above the river; total height above the foundation eighty-five feet six inches. The bridge affords the best view of the Falls of St. Anthony. It has 23 arches, and 16 of the spans are of 80 feet each. The structure cost about $600,000.

HONIGMAN'S CONDENSERS.

THE invention of Mr. M. Honigman, relates to the use of caustic soda, potash, or other liquids for the absorption of exhaust steam, and of the latent heat liberated by the condensation of the vapor and the combination of the water thus produced with caustic soda, and to the utilization of such heat in the production of fresh steam. Mr. Honigman's engines, therefore, require an additional vessel which shall serve both as condenser and heat generator. For the latter purpose particularly, the soda vessels evidently require to be constructed in such a way as to offer the greatest possible and most efficient heating surface for the water and steam of the ordinary boiler. In the tramway locomotive on which Mr. Honigman made his first public trial, this was hardly the case; and thus the trial, although fully establishing the possibility of the practical application of a principle, for which its first investigator in England, Faraday, saw no prospects in practical life, would not have been considered a success if it had simply been a question of how much power was developed per pound of coal consumed. The first trial has dispelled all doubts about the possibility of the application; but whether the great hopes that may attach to the novel condenser will be realized, will perhaps mainly depend upon the skill of the engineers to whom the perfection of the boiler may be intrusted. Scientists may meanwhile discuss whether the phenomenon is chiefly physical or chiefly chemical, or a combination of both.

A valuable investigation of the phenomena involved is contained in a paper recently brought before the "Verein Deutscher Ingenieure" by Professor A. Riedler, of the Technical College of Munich. Professor Riedler occupied himself during his academical holidays in August and September in experimenting with various boilers supplied with the Honigman condenser. For these tests, which were carried out at Mr Honigman's works at Grevenberg, near Aachen (Rhenish Prussia), Mr. Riedler had the able assistance of Mr. Gutermuth; and, further, the ready co-operation of Mr. Honigman himself, who supplied the necessary apparatus and encouraged the work in every respect, agreeing also to the publication of the results obtained with the first rather primitive plant.

The appended table, stating the boiling points (in degrees Centigrade) of mixtures of 100 parts by weight of caustic soda with ten and more parts of water, and the respective vapor tension, will facilitate an understanding of the processes carried out in the boilers.

Caustic soda.	Boiling point, deg. Cent.	Vapor. tension.
100 NaHO + 10 H_2O	236	-
" + 15 "	227	—
" + 20 "	220·5	—
" + 25 "	210	—
" + 30 "	200	—
" + 35 "	192·5	12·1
" + 40 "	185·5	10·2
" + 50 "	174·5	7·7
" + 60 "	166	6·1
" + 70 "	159·5	5·1
" + 80 "	154	4·2
" + 90 "	149	3·6
" +100 "	144	3
" +160 "	126	1·35
" +200 "	120	0·95
" +300 "	110·3	0,4
" +400 "	107	0·3

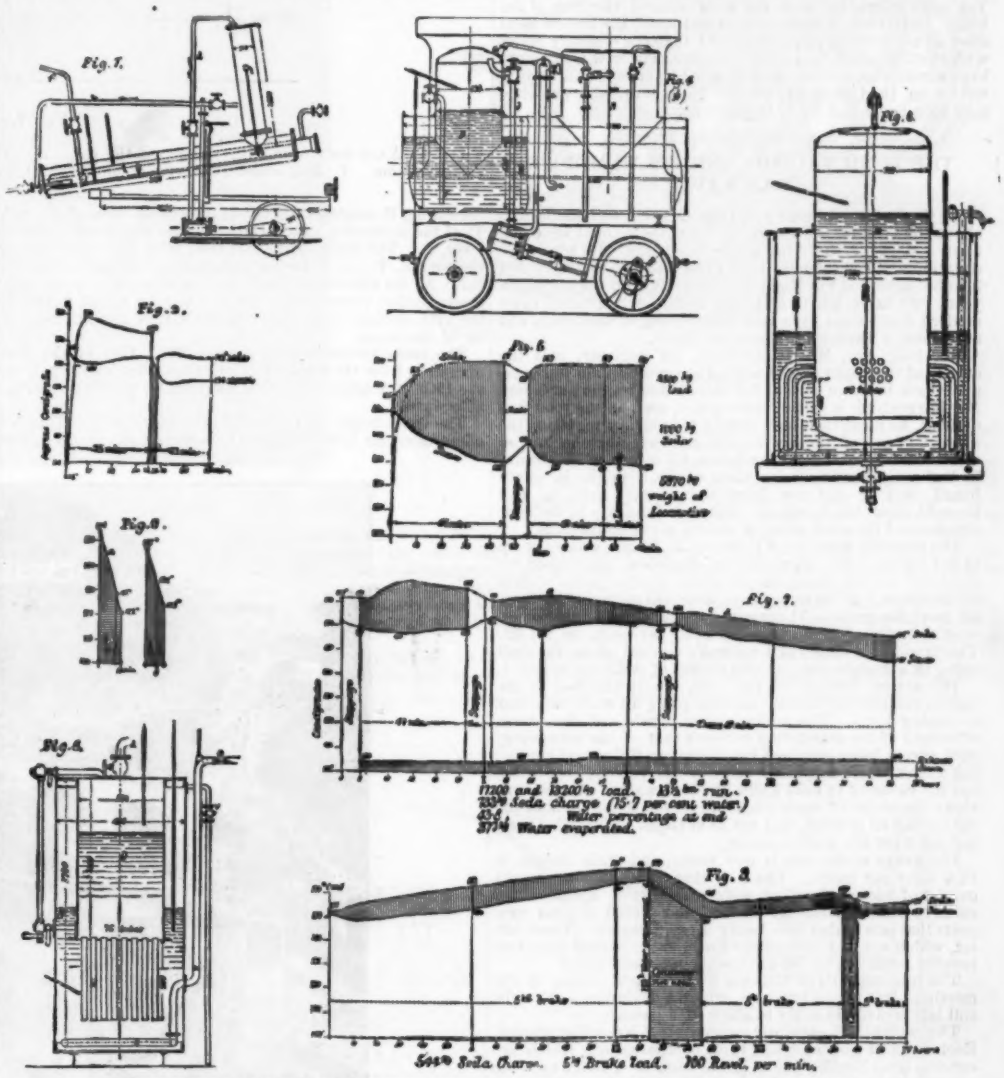
Fig. 1 on the following cut is a sketch of the boiler and engine which were employed for the first series of tests. The larger cast-iron cylinder of 210 millimeters (8¼ in.) in diameter and 3,150 millimeters (10 ft. 5 in.) long, with the vertical dome of 20·8 inches in height, contained the water, the inner wrought-iron cylinder of 6·1 inches in diameter, and 4 millimeters (⅛ in.) thick, contained the caustic soda. Steam from the boilers of the works entered through *f* into the outer boiler, and through *d* into the cylinder (5 inches in diameter. 0·7 inch troke) of a small engine, with a flywheel 28 in. in diameter, to which a brake could be applied. The exhaust steam passed through *a* and *o* into the lower end of the inner pipe, and through *e*, with the valve open, out into the air, if not fully absorbed by the soda. Three thermometers permitted of measuring the temperatures in the outer boiler, of the soda lye in the inner one, and of the exhaust steam. The quantity of water evaporated could be ascertained at any moment. The lye was, moreover, weighed before and after each test.

Experiment 1 commenced with water of 147 deg. Cent. (296·6 deg. Fahr.), and a charge of 35 kilos. (77 lb.) of solid caustic soda. As soon as the exhaust steam reached the soda, the temperature of the soda lye, which was now being formed, rapidly rose to 150 deg., while the vapor tension decreased. It took about 25 minutes to etablish a constant difference of temperature for the inner and outer boiler, the absorption and dissolution of the soda, and reciprocally the heating of the water or steam in the outer cylinder from this source, proceeding gradually. This difference of about 9 deg. Cent. was maintained for ten minutes, when steam appeared at *e*, showing that under the conditions existing, the soda was no longer able to condense all the vapor. For the next three minutes the exhaust steam was discharged directly into the air, without passing through the soda. During this period the steam temperature sank to 134 deg., and that of the soda to 143 deg.; the soda was then again capable of condensing; and continued so for 22 minutes. Fig. 2 is a graphic sketch of this test. The horizontal line marks the time, the vertical axis the temperatures in degrees Centigrade, the upper dotted curve represents the soda temperature, and the lower one that of the steam; the shaded space marks the pause during which the soda condenser was not working. Fig. 3 explains in the same way how quickly the temperature, sank when the same boiler, without any soda charge, and engine were worked with steam of 154 deg. (curve *a*) and 147 deg. (curve *b*). In both cases, the brake load of 10 kilogrammes (22 lb.) had soon to be reduced to 5 kilogrammes; but even then the engine soon stoped altogether. Numerous other trial showed that a considerable time would always elapse before a constant difference of temperature, the indication of a regular process, could be attained, and more satisfactory results would hardly be expected with this arrangement of boiler.

An old Schwartzkopff tramway engine served for the second series of experiments. The diameter of the cylinder was 5·70 inches with a stroke of 9·84 inches; the original boiler had been replaced by the one illustrated in Fig. 4. Here the inner space, D, was for the water; the outer, N, for the soda; the steam passed through *d* into the cylinder, and from there through *a* back into the soda condenser. This arrangement was not promising, the thin layer of soda at the bottom, between the plates of N and D, was exposed to all the cooling influences from outside, and would scarcely assist in heating D; then there was only one pipe at the side for the entrance of the exhaust steam. At the end of the tests, the soda at the bottom was found to have solidified; it probably was in this condition during the whole experiments, and the efficiency curves of Fig. 5, in which, as in the following diagrams, the shaded portions mark the active periods, and the blank spaces the pauses, illustrate the enormous difference of 44 deg. Cent. and more.

The trial runs took place on a line of only 262 ft. in length; at the end of each run, during which a pretty regular speed of 10 ft. per second was kept up, the brake had to be applied sharp, and the locomotive reversed; this, of course, necessitated an unusually high steam consumption, and the trials resembled what occurs on a steam tramway under most unfavorable conditions. When the boilers had been filled with soda lye of 155 deg., and water of 150 deg., it became neccessary to repair the manhole, which was not tight; and finally the experiment was started with fresh steam, but with the old soda, which had meanwhile cooled down to 120 deg. Still, Fig. 5 demonstrates that after forty-five minutes' run, and then a pause of ten minutes, the curves became parallel, although there was a space representing 40 deg. between them. Notwithstanding all these faults and difficulties, the boiler (Fig. 4) ran for six hours on several occasions, pulling a load of 5,500 kilogs., in addition to the locomotive weight of 5,870 kilogs., and a soda charge of 1,000 kilogs., making altogether about ten tons; and this is the same locomotive which took Mr. Honigman and his guests, seated in two cars, through the streets of Aachen when he, in June, first introduced his invention to the public

The next boiler, Fig. 6, was expressly designed to meet



HONIGMAN'S CONDENSER FOR TRAMWAY ENGINES.

not become continuous, but it would have considerable advantages over one rival at least, which it is claimed is especially adapted for steam launches, viz., the accumulator batteries, whose recharging or replacing is not at present reduced to practical conditions.

The fourth and last test boiler experimented upon was vertical, and served to drive a two-cylinder engine (cylinders 4·72 inches in diameter, 6·29 inches stroke) of form and size suitable for small steamers, the pipe discharging the exhaust steam making a turn and a half at the bottom of the basin, *n*. The results were satisfactory in so far as regularity of action was concerned, but the difference of temperature was again high, and from faults similar to those under which the boiler (Fig. 4) labored. Whether the improved boiler (Fig. 8), which was finally coupled with the same engine, really offers the most advantageous construction for distribution of heat, and a heating surface of constant size, need not be discussed here; the diagram (Fig. 9) at any rate speaks in favor of this pattern.

During these trials the soda boiler was either in communication with the air or not. If open, the soda stood under atmospheric pressure, and the period of absorptive capacity of the lye showed itself by the appearance of steam at the open valve. There was never any objectionable noise or foaming of the soda, except when rapeseed oil was used as a lubricant; mineral oils gave perfect satisfaction. When the soda boiler was kept hermetically closed, the limit of absorption had to be ascertained by watching a gauge in the soda boiler and a thermometer in the exhaust steam pipe; the latter kept during regular working periods steadily at 104 or 105 deg. Centigrade (2,200 Fahr.), in accordance with the requirements of the case. The water reservoir was again the inner vessel, but it had ninety pipes projecting into the soda lye; and the exhaust steam, issuing from a perforated spiral at the bottom of N, had to force its way right through, so that the dispositions for the distribution of heat and absorption were materially improved. In a preliminary experiment with 1,000 feet of water of 149 deg. Cent., without any soda charge, the locomotive with one empty wagon was after ten minutes unable to start at certain positions, and after twenty-four minutes unable to start at all. The satisfactory results obtained afterward with the soda condenser in action will be sufficiently clear from the diagram, Fig. 7; the two curves are regular and almost parallel, the difference of temperatures only amounts to 8 deg. on an average, and this difference was still further decreased during some of the other very numerous runs. To avoid the great waste of steam, caused by the frequent reversals on the short line, it was decided to stop simply by brake power; the dotted line, *a*, marks this change. At *d*, that is, after an active period of 2 hours 47 minutes, so much of the water in D had been evaporated and condensed in N that its line in D was only 3·15 inches above the heaters, while the lye in *n* stood 14·5 inches above this water line. This incongruity naturally led to overheating on the bare plates, which manifested itself in sudden increase of pressure, amounting finally to 0·4 atmosphere at each closing of the valve.

During some of the subsequent tests, the boilers were discharged and refilled when necessary. It is needless to remark that the quickness and economy with which this recharging can be effected will, to a great extent, determine the value of the new condensers. Even with suitable arrangements for quick recharging at intermediate stations, the process would not become continuous, but it would have considerable advantages over one rival at least, which it is claimed is especially adapted for steam launches, viz., the accumulator batteries, whose recharging or replacing is not at present reduced to practical conditions.

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We have not as yet touched upon the second but by no means less important side of the question, that is, the economy of the reconcentration of the soda lye. After a certain number of hours the soda will have become too diluted; it may be reconcentrated by evaporation, but it has yet to be ascertained whether it pays to run a locomotive without fire, but with soda as a condenser and fuel magazine, if afterward more coal has to be employed to make the soda again fit for further service? Time and circumstances did not allow Professor Riedler to investigate this point fully.

For want of sufficient soda lye, a mixture of solid caustic soda and water was for two days heated in a semi-globular open boiler with rather wasteful flues; each kilogramme of coal evaporated 4·5 kilog. (5·6 kilog. in a second experiment) of water from the lye, which was comparatively strong; the same boiler evaporated 6 kilog. of water per kilogramme of coal (440 lb. of coal yielding 2,640 lb. of steam).

That this reconcentration would not cause much additional cost and trouble on larger works is clear; for smaller installations, however, which do not justify the laying down of a special plant, this process will probably cause difficulty. Mr. Riedler assures us that practically no losses of caustic soda, arising from volatilization, could be detected; this may

at once be granted, but it would be more important to learn what percentage of the caustic soda became useless by absorbing carbonic acid, both during the process and the evaporation. The general conclusions arrived at cannot but be considered favorable to the new soda condensers or boilers. They have no pressure to sustain, are safe and therefore admissible in a wider sense than ordinary boilers; they work noiselessly and issue no smoke, and are in none of these repects inferior to their electrical rivals. That satisfactory efficiency can be attained has been proved; here they range again on a level with the electric motors. They do not want any fire, nor do they give sparks; for transmission of power to a distance, they require very careful provisions against losses to heat by radiation, but any deficiency in this respect simply involves loss without bringing danger, as from bad insulation. It has, moreover, been recognized that practically soda lye with about 20 to 25 per cent. of water, corresponding to a boiling point of 210 deg. (410 deg. Fahr.), will answer best; if now a pressure of four or five atmospheres is sufficient, as it will be in many cases, this pressure may be obtained by feeding the boiler with water of from 80 deg. to 90 deg. (176 deg. to 194 deg. Fahr.), that is, water below its boiling point. That would be a material recommendation. Defects of the soda boilers will no doubt become manifest when they are in regular use. A deterioration of the metal used may be feared, and would be a serious matter but this objection is not fatal, since the caustic alkalies are, at present, commercially concentrated in iron vessels. Both wrought iron and cast iron are not supposed to be attacked by caustic soda below 200 deg. Cent. (390 deg. Fahr.), and the boilers stood their three months' working period very well. Yet even assuming that the soda attacks the iron of the boiler, and damages both the iron and itself, the boilers need after all not become more shortlived than the ordinary boiler with the fire outside and the scale inside. The new condensers have already been introduced at some tramways and mining works on the Continent, so that further valuable evidence may soon be looked for.—*Engineering.*

THE RIGHI VAUDOIS AND ITS WIRE-ROPE RAILWAY.

AT the eastern extremity of Lake Geneva, and 350 meters above the level of its waters, is built the hamlet of Glion upon a slope of the Alps above Montreux. Its admirable situation and the splendid view to be had there have caused it to be surnamed the Righi Vaudois. Within the last thirty years two large hotels and two boarding houses of more modern dimensions have been built there in succession and are annually receiving numerous visitors.

Not long ago, Mr. Riggenbach, an engineer, and the author of the Righi and of several other mountain railways, undertook to do an errand for some ladies residing at Glion. Mr. Riggenbach is getting on in years, and, as the road was difficult, he more than once during his journey regretted the absence of one of those wire rope railways that he had so often constructed. So, even before his return to Montreux, he had sought and found a place where it might be established, and he did not leave the country until he had brought about the movement that ended quickly in the construction of the road which is shown in our engravings.

The roadway measures 674 meters in length and runs up to 312 meters. No other railway, doubtless, established for passenger service, has a steeper grade, except, perhaps, that of Vesuvius. At its upper part, over 345 meters of horizontal base, the grade is 57 per cent., or 29° 41'. At the lower, over 95 meters, it is no more than 30 per cent., or 16° 42'. The junction is made, in a naturally vertical plane, the road being in a straight line, by two curves of different radius.

The system consists of two cars, simply attached to the two extremities of a cable, and one going up while the other is coming down. The motive power consists of the excess of weight of the descending car over that of the ascending, such excess being obtained by alternately filling and emptying a tank which is placed beneath the vehicle, and which has the capacity to hold 7,000 liters of water. A rack runs along the center of each track and serves solely to hold the car during its descent, and not as at Righi to furnish a bearing point for the motive power.

The gauge of the rails is one meter, and their weight is 17·4 kilos per meter. The ties that carry the two tracks consist of pieces of rail of wide base, turned upside down so as to present sufficient surface, and bolted to iron supports that are sealed into heavy dressed stones. These latter, which are laid in stairway form, are cemented upon two parallel walls. The ties are spaced one meter apart.

The internal rails of the two tracks touch, except at the meeting place of the two cars, where a deviation to the right and left is made in order to allow of a passage.

The weight of each car, empty, is 7,300 kilogrammes. Each seats 24 passengers in three compartments, which are entered from landing places in the form of a stairway. An upper compartment, which is designed for baggage, may, when there is need of it, afford standing room for six passengers. Finally, each car carries two brakemen.

The cable under test broke under a load of 57 tons. At first there was another cable tried which was formed of a central strand of hemp, of 12 or 15 millimeters, wound with 7 strands, each formed of 19 steel wires 1·9 mm. in diameter; but this was deemed insufficient, although it supported 47 tons before breaking. The total diameter of the cable is 33 millimeters, and it is tarred throughout. Its attachment to the car is effected by means of a sort of cast iron funnel. At a short distance from its extremity a strong ligature of iron wire was placed on the cable, and the latter was introduced, along with the former, into the cylindrical part of the funnel. After this, the extremity of the strands was untwisted and divided in all directions. The bundle thus formed was then drawn into the conical part of the funnel, where it was fastened with molten zinc.

The upper pulley, which is placed in the plane of the track, and around which passes the cable, is 3·57 meters in diameter at the channel.

Of brakes, there are three to each car, each of which has a special and slightly different function, although all concur in the same object. The car has two axles, upon each of which is fixed a steel toothed wheel that engages with the rack. The latter is formed of two cheeks of U-iron, 12 mm. in thickness, coupled by the riveted steel toothing. The width of the toothing is 120 mm., the pitch is 100 mm., and the dimensions of the teeth are 43 and 36 mm. Iron catches fixed beneath the car embrace the upper flange of the U-irons and prevent any ungearing through lifting. These racks are exactly the same as those of the Righi.

Upon the front or lower axle are fixed, to the right and left of the cogwheel, two brake drums having numerous channels and situated between two bronze friction blocks that are capable of being locked by levers. One of these systems is maneuvered by the brakeman of the descending car, who must never desert his lever. The other system is automatic and only works in case of breakage of the cable. Nevertheless, the brakemen can actuate it, if need be, by means of a handle that is within his reach.

To make the operation of the brake better understood we give a theoretical design of it. Upon an axis designed to lock the automatic brake there are fixed two levers—one of them a short one, to which is attached the cable, and the other a long one, which carries a heavy counterpoise that is held by a very sensitive detent. In case the cable breaks, the spring, R, expands and causes the escape, through the rod, T, of the ungearing lever, D, that carries the extremity of the lever, L. The latter, being left free, falls and carries along the weight, P, and locks the brake against the axle, A, of the car. As the adherence would not, on account of the steep grade, suffice to hold back the car, a gear wheel, keyed to the axle, engages with the teeth of the rack fixed in the center of the track.

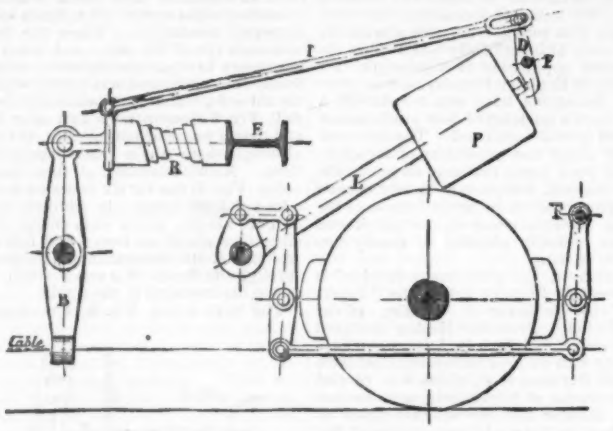


FIG. 2.—BRAKE.

F F F F. Axes stationary with respect to the car. B. The lever which compresses the spring, R. E. Cross brace of car frame. T. Rod which causes the detent lever, D, to escape. L. Lever carrying a counterpoise, P.

The brake blocks last for a long time. Out of the four operating from the opening of the road, that is to say, since the 19th of August, only three had been replaced two months afterward.

The third brake is applied to the other axle. This is a compressed air brake designed to moderate the descent automatically. The axle carries a second gear wheel that actuates a crank shaft by means of a pinion, and this shaft actuates a pump which compresses air into a reservoir. The more the air is compressed the more resistance is experienced by the force which causes the crank shaft to revolve and which is produced by the progression of the car. The brakeman regulates and moderates the working of it at will. When the car is ascending the pump runs empty.

During fine weather, when numerous strangers were visiting this picturesque country, the trains (of which there are still 12 a day) succeeded one another almost without interruption. It takes about nine minutes to make the trip, and the regulation speed is 1·25 m. per second. Despite all measures and precautions that are taken to secure the entire safety of travelers, this mode of locomotion cannot but help give rise to certain apprehensions, and more than one looks twice before venturing to undertake such a voyage. Ten thousand tickets were nevertheless distributed the first month, and eight thousand the second, the latter having been less favored by the state of the temperature. The fare for the round trip is 1·5 francs. It is doubtless the sight of the dizzy incline which makes one hesitate to go up in this sort of an elevator of 57 to 100 gradient, while one trusts himself without any fear in a vertical elevator whose gradient is *infinity per hundred.* One experiences, moreover,

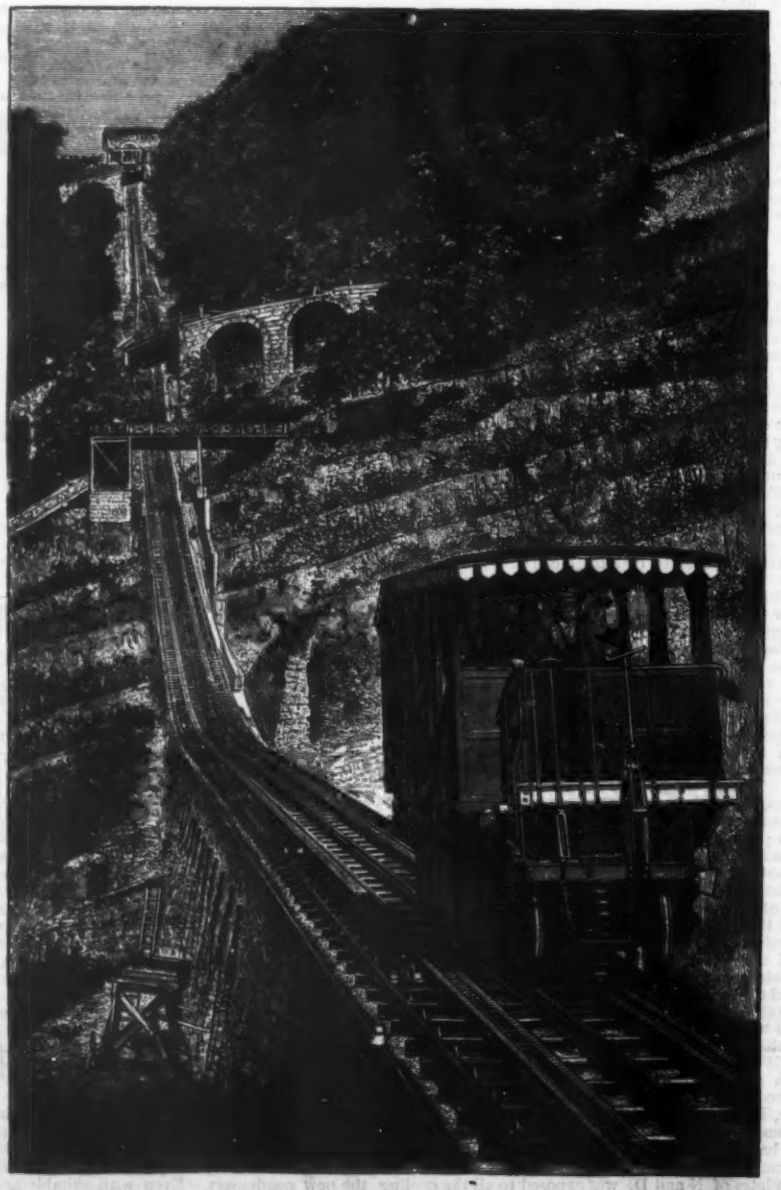


FIG. 1.—THE RIGHI VAUDOIS WIRE ROPE RAILWAY.

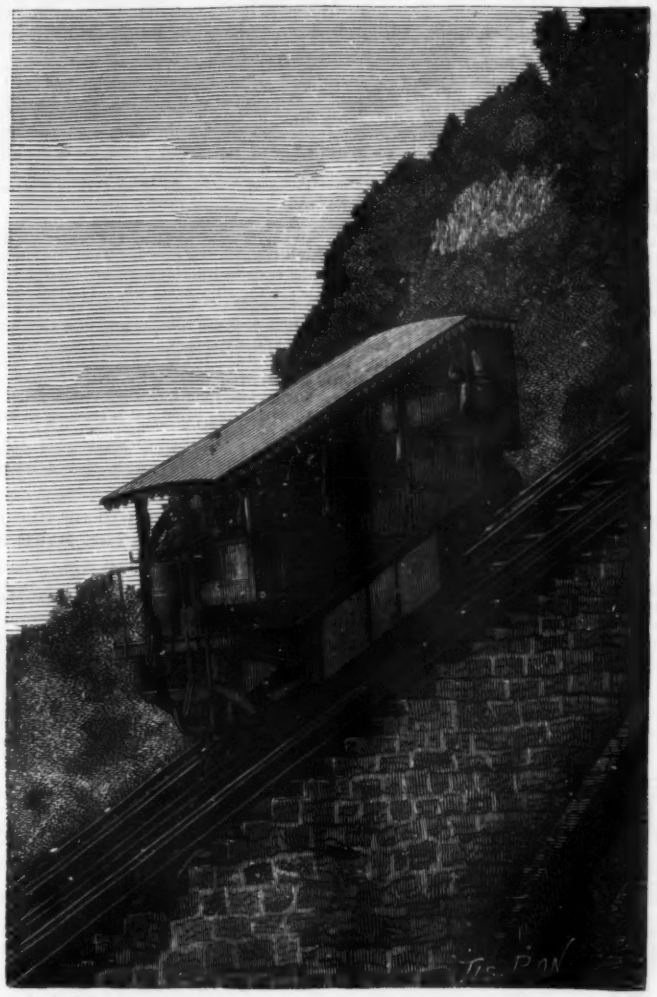


FIG. 3.—THE RIGHI VAUDOIS WIRE ROPE RAILWAY.

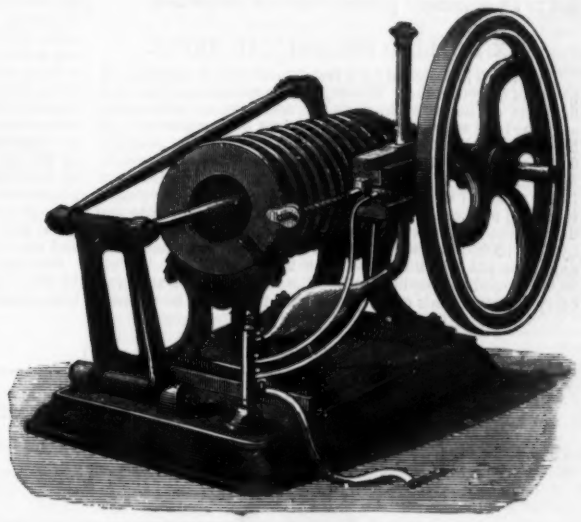
more pleasure in viewing the sliding of the cars from one of the bridges under which the tracks pass than in being in one of the upgoing or downcoming trains. There is a double inconvenience connected with the inequality in the grade. In the first place, at the junction, the tension of the cable makes it jump from its rollers, upon which it does not always fall back again the same. Sometimes then the cable jerks if the brakeman does not handle his lever properly, and this may cause the automatic brake to act. In the second place, the weight of the descending car is, upon the lower part of the incline, insufficient to draw the other one up. Everything comes to a standstill then until re-enforcements arrive from the station to increase the load. There results from this a certain amount of uneasiness among the travelers in the ascending car, some of whom begin to think they are already victims of some accident.

To remedy this the tank is filled entirely full of water from a large reservoir of 120,000 liters capacity, and not so much account is taken, as at first, of the weight of the loaded car, the number of whose passengers is telegraphed in both directions. When the foot of the incline is reached, a lever, coming in contact with a tappet, empties the tank automatically.

The first trial trip was an audacious proceeding, and succeeded at the first onset in securing the public's confidence. The venerable and popular engineer Riggenbach, surrounded by his staff, was, on this occasion, the first to descend the dizzy incline *with untried brakes and without a cable*. The car stopped, started, stopped again, and obeyed the signals that were made to it according to his fancy by one of the promoters of the affair who was standing on one of the bridges. The success was very great and exceeded all hopes.—*Le Genie Civil.*

FOREST'S GAS MOTOR.

THE new Forest gas motor, which is at present running in the machine hall of the Conservatorie des Arts et Metiers,



FOREST'S GAS MOTOR.

constitutes one of the simplest types of this sort of engine that has thus far been devised.

As shown in the accompanying figures, it consists of a cast iron base, A, to which are bolted two standards, B, which support a cylinder, C. This latter is cast in a piece with a helix, the object of which is, by offering a greater surface to the surrounding air, to facilitate the cooling of the cylinder when heated by successive explosions of the gaseous mixture. In the cylinder, C, there is adjusted a piston, P, which is connected by a rod, D, with a rocking lever, E. This latter, which is jointed at its lower extremity with the base, A, oscillates under the action of the connecting rod, D, and communicates motion to the driving shaft, G, by means of the connecting rod, F, and the crank, G'.

The driving shaft rests on two pillow blocks, H and H',

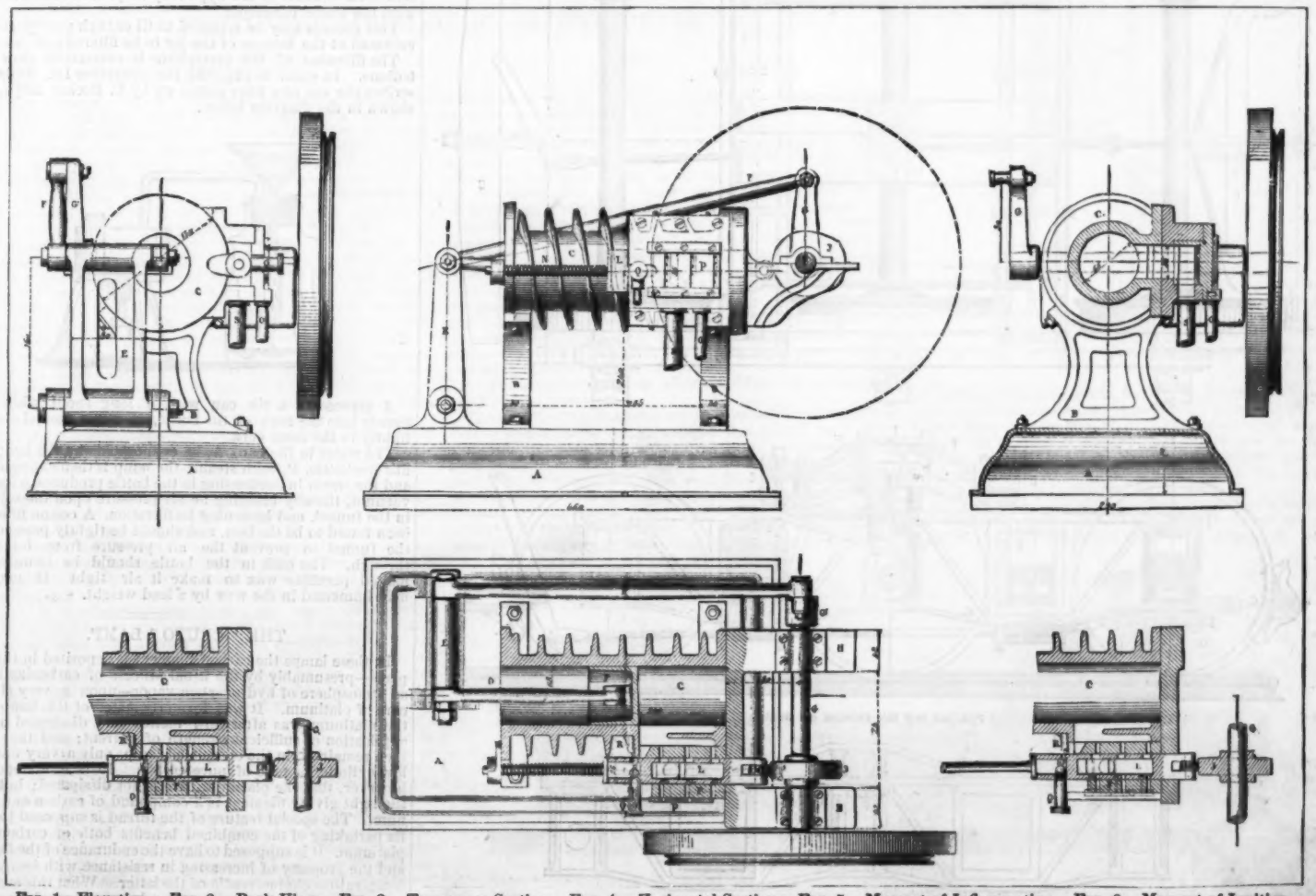


FIG. 1—Elevation. FIG. 2.—Back View. FIG. 3.—Transverse Section. FIG. 4.—Horizontal Section. FIG. 5.—Moment of Inflammation. FIG. 6.—Moment of Ignition.

FOREST'S GAS MOTOR. (Scale of 0·25 to 1.)

cast in a piece with the front plate of the cylinder, and is provided with a cam, J, that acts upon the distributing slide valve, L, which carries a roller, M, at its extremity. This valve, which is thrust forward by the cam, J, at every revolution of the fly wheel, is pulled back to its initial position by a spring, N.

The gas for actuating the motor enters, through the pipe, O, the ports of the valve seat, P, which is also provided with ports for the entrance of the air. The gas and air mix in the hollow part of the valve, L, and are afterward distributed in the cylinder, C, where they are inflamed by means of the burner, Q, which is fixed to the slide valve and becomes lighted by the burner, R, at every stroke of the piston. To permit of regulating the entrance of the air, according to the speed that it is desired the motor shall have, the valve seat, P, is provided with a small movable plate containing vertical apertures, and capable of being moved at will in a horizontal direction so as to partially cut off the air ports.

The escape takes place through the pipe, s, which communicates with the interior of the distributing slide valve. This motor is made in five different sizes, of 4, 10, 15, 25, and 75 kilogrammeter powers.—*Annales Industrielles.*

SIX WHEELED FREIGHT CAR TRUCK.

THIS truck is designed for a freight car with a carrying capacity of 80,000 pounds. We are, unfortunately, without specifications of the size of the car body, and have no information as to the total weight of car or the weight on the journals. If, however, the limit of weight per journal should be placed at 9,000 pounds for the M. C. B. standard axle, as suggested by Mr. Blackall at the December meeting of the Car Builders' Club, a pair of these trucks should be capable of carrying a total load on the journals of 108,000 pounds. Considering that double iron transoms are used, and that the side sills are 7¾ by 15½ inches, the weight of the car alone, less wheels and axles, cannot be much less than 28,000 pounds, leaving 80,000 pounds of paying load. The value of a car that can carry 40,000 pounds of freight on each truck will be appreciated upon roads where there are ore and stone to transport, or other material for concentrated loads.

The truck is of the type formerly known as the "California Truck." The sides consist of a deep truss formed by three archbars, the upper bar being 3×1⅛ inches, the middle one 3×1 inch, while the bottom bar is between ⅜ and ⅞ inch in thickness. This form of truss, on account of its depth, and its short compression members, is a strong one. The side-bearings, carried over the central axle, are supported by a separate truss, F G. The journal box guides and the irons by which the transoms are held are shown in the plan view, and are arranged in such a way as to form important members of the truss. The transoms themselves, as will be seen on the outside of the swing-beam, B B, are formed of two ⅛ inch iron plates on the inside, and a ⅜ inch plate on the ontside, separated by a space of 1¼ inches. A section of these combined transoms is shown in the transverse half section view. Short thimbles are used as distance-pieces to keep the plates apart. These and the arch-bars form the truck frame.

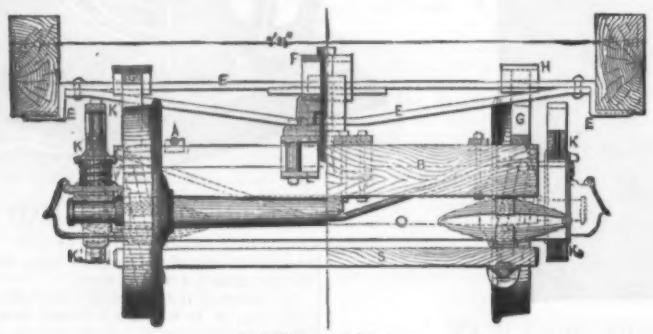
The rigidity of the frame in a horizontal plane is dependent upon the bolts and 1½×3 inch jaws which hold the transoms. The swing-beams play between the double transoms, and are firmly held by a system of bracing and trussing which carries the center plate. There are two center bearing arch-bars, each 6×1 inch, bolted at the ends to the swing-beams, which are also connected by the round bars, A A, passing directly from one to the other, the ends of the bars being turned down into the timber. All these connections are very strong and heavy, but not more so than is required by the load to be carried. The spring planks, S S, are hung by four links each, the links standing in at a small angle and placed between the transom plates. Four 6 leaved elliptic springs are used on each, and are carried by pockets in the usual way. M. C. B. standard axles and oil boxes are used, and over each box is a spiral spring.

Owing to the unusual length of the truck, which is over 12 feet, the brake arrangement is somewhat peculiar. One brake-beam, C_2, is of wood of the usual pattern. The other, shown at C, is of iron, trussed, and is arranged so as to extend as little as possible beyond the wheels, the total projection beyond the flange being equal to the thickness of the brake-head plus the nut and washer. A piece of blocking outside the twisted end of the iron beam is used to fill up the head of the shoe and make a firm hold for the bolt.

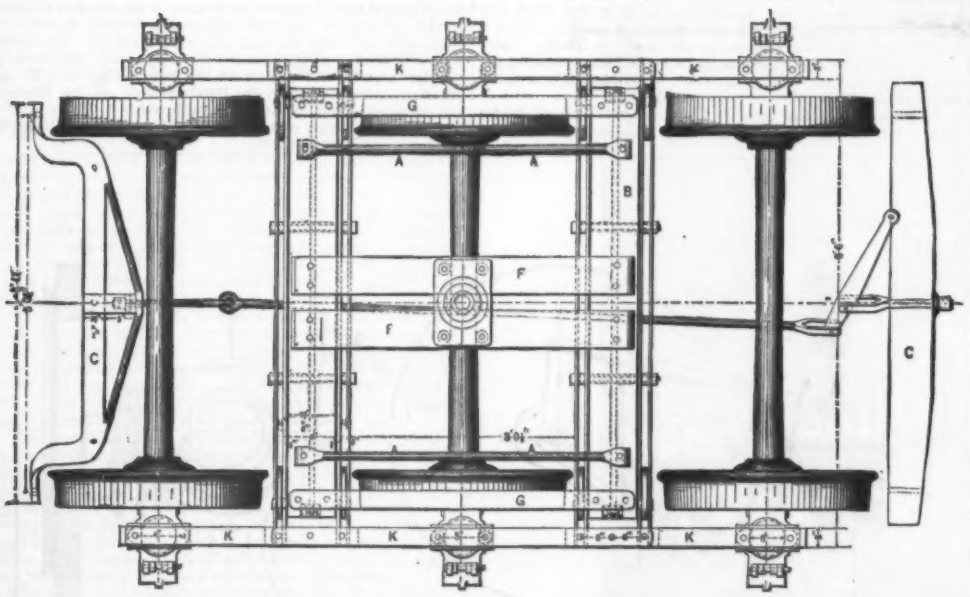
The depth of the swing-beam requires the brake-rod to be brought very low, and the bending of it so as to make the peculiar attachment shown at D. This consists of a flat piece of iron doubled over the beam and bent at right angles so as to form a drop through which a short rod is passed. This rod, by means of an eye, is attached to the lower brake-rod.

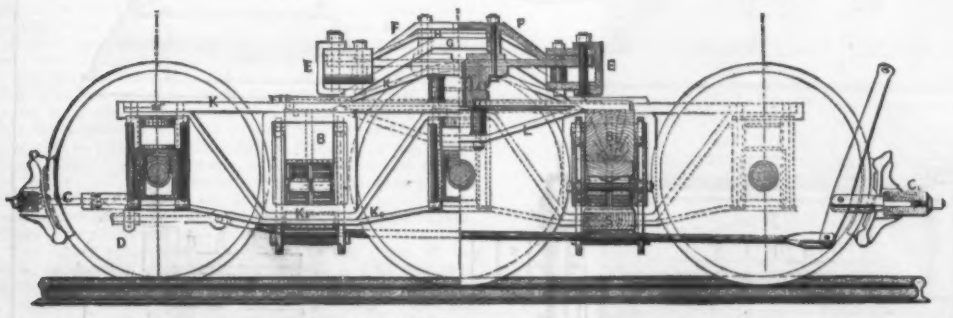
The transom, E E, shown in the end view and section, is arranged so as to bring the center plate as high as possible and the sills low down. The sills are 15½×7¾ inches, and the ends of the transoms are turned down and extended beneath the sills as shown. The transoms are double, and are connected by strong braces, as shown in the side elevation, where E E are section and end view and F F the connecting and arch-bars.

The truck is about 8½ feet from outside to outside of sill and 6½ feet outside the truck frame. The top of the sills is a trifle less than 4 feet above the rails. and the king bolt, as shown in the drawing, is scarcely 6 inches from the under side of the floor. The swing-beams are 7⅜ inches square, and the spring-plank about 8×9 inches. The brake-beam is about 7¼ inches wide and 4 inches thick.—*Nat. Car-Builder.*

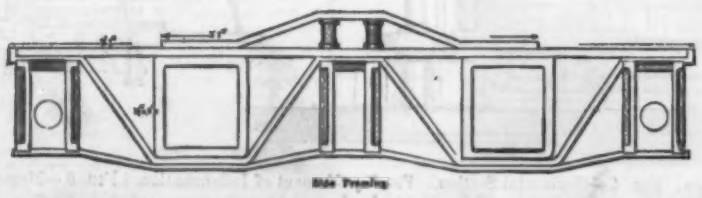


End View and Section.





Plan and Half Side Elevation and Section.



Side Framing.

SIX-WHEEL FREIGHT CAR TRUCK, CENTRAL PACIFIC RAILROAD.

IMPROVED METHOD OF RECOVERING SILVER FROM THE HYPO BATH.

THOSE who are familiar with gelatine dry plates must be aware of the large amount of undeveloped bromide of silver film there is left on the plate after the development of the exposed image. For the purpose of dissolving the unused bromide of silver and clearing the negative, it is immersed in a bath of hyposulphite of soda. The bath, in the course of time, naturally becomes highly charged with the dissolved silver bromide, and many processes have been devised for recovering the waste silver therefrom.

One of the most simple is to pour into the hypo bath a saturated solution of sulphuret of potash, which immediately throws down the silver in the form of a black, flaky precipitate.

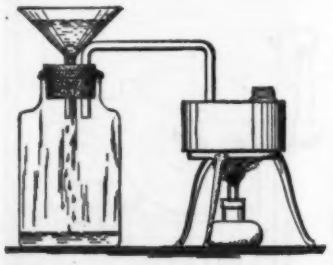
The principal objection to this process is the disagreeable smell of sulphureted hydrogen gas given off, which is especially annoying when large quantities are used. The gas also does damage by injuring chemicals, sensitive plates, and paper within its reach. Dr. Lagrange, a German chemist, recommended the use of a solution of ferrous oxalate, but as this is expensive its use has not become general. Quite recently Dr. F. Stolz, editor of the *Wochenblatt*, has followed out Legrange's idea by suggesting the use of the waste ferrous oxalate or pyro developer for precipitating the silver; a plan which is of practical use to the photographer and amateur. The precipitation of the silver is slower by this process than with the sulphuret of potash, but it possesses the advantage of utilizing the waste developer, which is usually thrown down the sink.

After the old hypo bath has been poured into a stone jar or any old vessel, the waste developer is mixed with it from time to time after it is used. Repeated pourings of the developer will, after a time, precipitate all the silver.

When all the silver has been apparently thrown down, a little of the clear liquid at the top is taken out in a test tube and tested with a solution of sulphuret of potash; if no precipitate occurs, all of the clear liquid above the precipitate in the bottom of the jar may be decanted off, and the next saturated solution of old hypo may be poured in and treated with the waste developer.

This process may be repeated until enough precipitate has collected at the bottom of the jar to be filtered and washed.

The filtration of the precipitate is necessarily slow and tedious. In order to expedite the operation Dr. Stolz describes the use of a filter gotten up by C. Becket Loyd, and shown in the diagram below.



A represents a tin can with a long spout which fits tightly into the cork of the bottle, B. The funnel also fits tightly in the same cork.

The water in the can, A, is evaporated by the lamp and fills the bottle, B, with steam; the lamp is then extinguished and the steam in condensing in the bottle produces a partial vacuum, thereby bringing an air pressure upon the solution in the funnel, and hastening its filtration. A cotton filter has been found to be the best, and should be tightly pressed into the funnel to prevent the air pressure from forcing it through. The cork in the bottle should be immersed in melted paraffine wax to make it air tight. It may be held immersed in the wax by a lead weight.

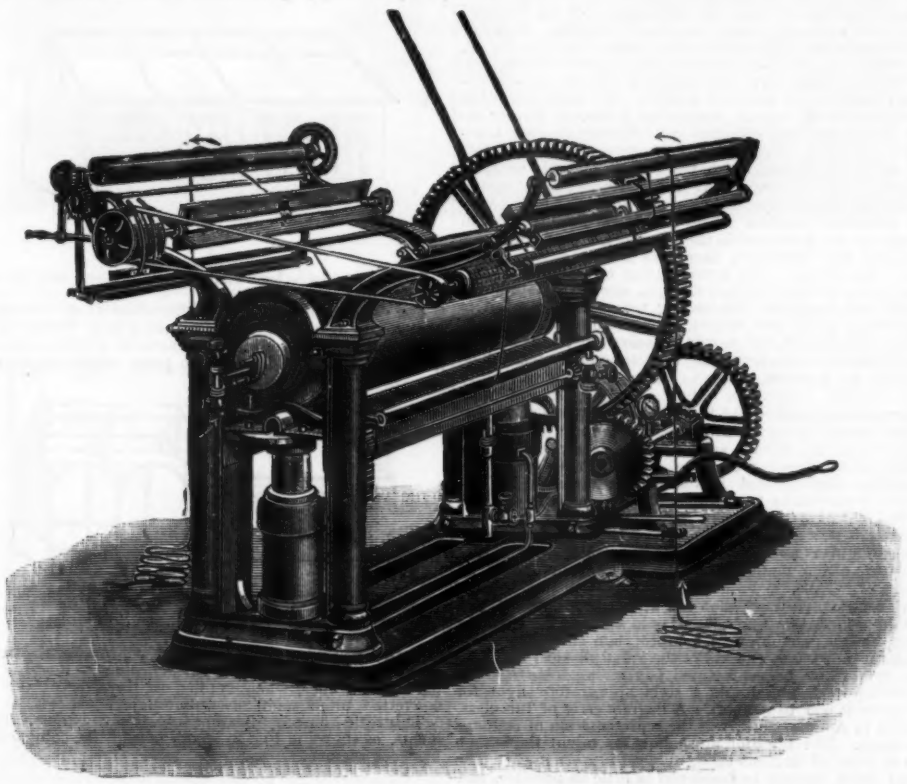
THE "CRUTO" LAMP.

IN these lamps the carbon filament is deposited in the first place—presumably by the usual process of carbonization in an atmosphere of hydrocarbon vapor—upon a very slender core of platinum. It was formerly stated of this lamp, that the platinum was afterward melted and dissipated by the application of sufficient strength of current; and that there then remained, in the completed lamp, only a very fine hollow cylinder or pipe of pure carbon. It is now reported, however, that the platinum core is not dissipated; but that the light giving filament is a compound of carbon and platinum. The special feature of the thread is supposed to be in its partaking of the combined benefits both of carbon and platinum. It is supposed to have the endurance of the former, and the property of increasing in resistance with increase of temperature characteristic of the latter. What this means is very easily seen; for as the carbon loops commonly used decrease in resistance with increment of temperature, the hotter and more luminous they are, the more current they re-

quire in order to keep up their brilliancy. Owing to this presumed advantage of the "Cruto" lamp, it is reported that specimens have been found to give 17 candle power with an expenditure of 32 volt-amperes, while not less than 60 volt-amperes are given, by the *Electrical Review*, as the usual expenditure upon the 16 or 20 candle lamps commonly used in England. The data for the "Cruto" lamps are drawn from a very few picked examples, and even the electricians doubt whether they mean much; although, in point of fact, they are the highest record yet obtained from any form of incandescent lamp.

IMPROVED HYDRAULIC CLOTH PRESS.

THE value of hydraulic pressure is daily recognized more and more, and it is in consequence applied in various ways. Its chief merits are easy application, simplicity in construction, greater pressure than is possible by levers, screws, or weights, and absolute certainty to a given pressure—as indicated by the pressure gauge. These advantages have induced machine makers to apply it to calenders, mangles, and similar machines where a high pressure is required, and we have on several occesions illustrated presses constructed



IMPROVED HYDRAULIC CLOTH PRESS.

in this manner. On the Continent continuous presses for finishing cloth have found more favor than with us, and as their construction has lately been considerably improved, we herewith illustrate one of the latest forms of press of this description, which seems to have many points of advantage over previous ones. The older constructions contain a revolving cylinder, between which and a concave surface the cloth passes under pressure, while its passage is assisted by an endless cloth which goes through the press with it. This cloth has always been a source of trouble, for through the pressure it lengthened, and the arrangements for keeping it in tension had therefore to be constantly attended to. In the new press this inconvenience is removed, the endless cloth being replaced by a felted flannel, which is wrapped around the cylinder. The main frame of the machine contains four hollow pillars, which carry the fixed revolving pressure roller, of polished cast iron and 22 in. in diameter, and the whole—including the driving gearing—is fixed to a cast iron foundation plate, so that the machine can be placed with ease upon any floor, and does not require a stone foundation. Below the cylinder is the convex mould, which rests upon the pistons of two hydraulic pumps, and can be instantly lowered by lifting the lever of the safety valve. The pressure is upon both sides of the mould simultaneously, and equally, in order to obtain a uniform finish throughout the whole width of the cloth, which goes through the machine in its full width. The presser roller as well as the mould or table can be heated by steam. The roller is in communication with a double pipe, one of which introduces the steam while the other takes away the condensed water. The mould or table below the roller is connected with two of the hollow pillars, one of which, arranged telescopically, brings the steam to it, while the other carries the water off. Before the mould a finely perforated copper box is placed, which is in connection with a steam pipe, and by means of which the cloth—when it is to dry or when it is to receive a high gloss—can be damped. In front of the machine carrier and spreading rollers is fixed a revolving brush, and behind it a batching apparatus with a fan to cool the cloth after pressing. The cloth is introduced into the machine so that the attendant has its face before him. When the cloth is to be steamed it is not plaited down by the machine, but after receiving an extra pressure run upon a roller. The construction is sufficiently strong to withstand a pressure of 40 tons applied to the cylinder, while on the other hand the lightest pressure practically required can be given if the safety valve is fixed accordingly. In this way the pressure for each kind of cloth can be fixed beforehand, and the attendant is unable to alter it. The mould is faced with a plate of highly polished German silver, which gives the cloth a clear, fine appearance, and it can easily be renewed when damaged.—*Textile Manufacturer.*

PERRET'S SPONGE FILTER.

FOR the physical and mechanical purification of juices, sirups, and other liquids, Mr. A. Perret proposes to suppress the use of animal charcoal and to substitute an apparatus whose structure and mode of operation we shall herewith describe. Whatever be the *role* of bone black in the clarification of saccharine juices, the fact remains that the results obtained by using it are costly. Aside from its decolorizing power, due to the carbon that it contains, animal charcoal owes all its purifying properties to its porosity and its great capillarity. After the last carbonation the juices that reach the filters are more or less defiled with bodies either dissolved or in suspension—such as lime, organic matters, alkalies, etc. In order to obtain pure and limpid juices they must be made to penetrate the pores of the bone black, but, in measure as the grains accumulate and become obstructed, the efficiency of the black progressively diminishes. In order to restore such efficiency it is customary to proceed to wash the filters with warm or cold water; but this very water brings with it a certain quantity of earthy salts in suspension, and also becomes charged with all the impurities that it removes from the black before being mixed with the juices to be evaporated. The earthy salts deposit upon the tubes, while the impurities derived from the cleaning continue to defile the juices up to the process of boiling. On another hand, there remains in the filter, after the washing operation, the animal black whose efficiency is lost, and which must be renewed or submitted to revivification. This latter operation requires for its prosecution a costly plant and several manipulations that precede the reconstruction of the charcoal filter. Besides, the properties of the revivified material have perceptibly diminished, since, independently of the *adherent* carbonate of lime, a portion of the carbonate and phosphate of lime constituting the black are attacked by the hydrochloric acid. Afterward, during the boiling, the sugar and organic matters that have escaped the washings undergo vitrification and form a brilliant and non-decolorizing carbon whose fragments stop up the pores of the bone black and imprison the salts therein. Then the black, which weighed 60 kilos per hectoliter, reaches, after revivification, a density of 110 kilos per hectoliter.

These difficulties have for a long time attracted the attention of specialists to the advantages that would be derived from filtering juices by mechanical means. Attempts have been made at different times to filter through sand, cinders, cloth, Taylor's bags, etc., and, in following this direction, Mr. Perret has been led to the devising of a filter which acts at once mechanically and physically. His apparatus, which is shown in the accompanying cut, consists essentially of a mass of but slightly twisted cotton woven with large meshes (or other spongy bodies selected according to the liquid to be filtered) and dipping into an iron plate back of indefinite length and of a section of about 45–60 centimeters.

In order to give the juice to be filtered numerous surfaces of contact, partitions made of perforated iron plate or wire cloth are placed throughout the length of the back, at a distance of 20 centimeters apart, and, between each of these, the cotton fabric is held in numerous folds. These sponge frames thus formed constitute the elements of the filter. During filtration the saccharine juice, under pressure, reaches one of the extremities of the apparatus and traverses the various partitions in succession, becomes freed of all its impurities, and reaches the other end entirely limpid. If the liquid is charged with sediment, this is arrested mechanically by the first frames, and the still turbid liquid becomes clarified during the remainder of its passage—this time by physical filtration. In fact, the infinitely tenuous and numerous fibers of the cotton exert, by reason of their mass and surface, an effect of molecular attraction upon all the bodies contained in the surrounding liquid; and thus all the particles in suspension approach the fibers slowly and attach themselves to them. Independently of the calcareous salts and of all the bodies in suspension retained by the sponge filter, a certain quantity of soluble salts contained in the juice is also eliminated, as is shown by analysis.

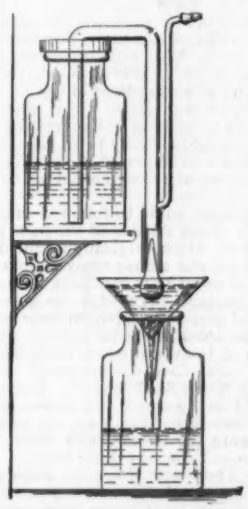
Mr. Perret has several times ascertained that the apparatus is capable of absorbing, and consequently of removing from the juices, a much larger quantity of organic matters than bone black does. Moreover, the fermentation engendered by the stagnation and cooling of the juices is avoided in liquids that traverse this filter, since, in the case of a normal discharge, each division is traversed by 50 hectoliters per hour. But, notwithstanding such velocity of flow, the liquid appears to remain at rest between the partitions. In practice, sirup is first sent through a sponge filter, then juice, and, after 6 or 8 hours' running, a clean filter is resorted to and the one that has been used is washed.

The operation of cleaning is very simply performed. In the very first place the juice remaining in the filter is transferred to the filter presses. Then the filter frames are lifted a few centimeters in order to facilitate drainage, and afterward they are washed *in situ* by working them up and down in water flowing swiftly through the channel of the filter. When the first washing is finished, a second is performed, and the filter thus revivified is then ready to effect a new clarification as efficacious as the first. The water used for washing is led out of doors, as it contains nothing but the foreign bodies that have been arrested by the filter.

This new filtering apparatus presents, among other advantages, that of preserving all its purifying properties for a period of two years, that being the length of time that the cotton lasts. Moreover, the use of it permits of a reduction in the expenses of manual labor and installation. This mode of filtration may likewise be employed for treating lime water designed for feeding steam boilers, and is, in fact, adapted for operating upon liquids that need clarification, such as cane juice and sirup, stearine, precipitated extracts of woods, etc.—*Revue Industrielle.*

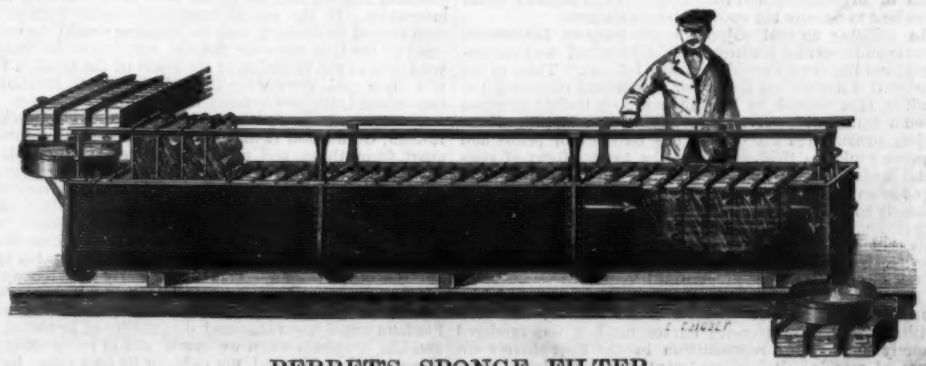
IMPROVED AUTOMATIC FILTER.

OUR diagram illustrates an improved method of supplying a liquid to a funnel filter, invented by Mr. E. E. Robinson, and described in the *Chemical News.* When large quantities



of liquids, such as reagents, have to be filtered in the laboratory, it is often convenient to have some means by which the funnel filter may be kept filled. The handling of large bottles for the purpose of emptying the liquid into the filter is disagreeable and tiresome. By the arrangement shown below such labor is avoided and the liquid is at the same time silently but surely transferred to the filter.

To the longer limb of the siphon is attached a short rubber tube. Operating vertically within the lower end of the tube is the narrow conical stem of a glass bulb float, in



PERRET'S SPONGE FILTER.

the bottom of which are two or three small lead shot or weights for the purpose of retaining the stem of the float in a vertical position.

As the liquid in the funnel filters out, the glass bulb descends, which in turn opens the bottom of the surrounding rubber pipe and permits the liquid in the siphon to flow out, falling over the bulb. If the liquid from the siphon flows faster than that through the filter, the bulb rises, and by its conical form wedges against the inner lower periphery of the rubber pipe, plugging the same, and stopping the flow therefrom. By this means the funnel is kept constantly supplied until all the liquid in the upper bottle has been siphoned out. An important advantage of this arrangement is that when once started it can be left without attention until the filtration is completed.

ORNAMENT.

AT the London Institution, Mr. H. H. Statham lately delivered an interesting address on this subject. The lecture was illustrated by a large number of colored designs and drawings, and by collections of casts and textile fabrics lent by the authorities at South Kensington Museum. Having disclaimed any intention to treat the subject historically, or to bring forward suggestions for original designs, Mr. Statham said he should purposely omit all reference to color, as its use stood on a different footing from design; color was partly governed in its choice and use by physical laws, whereas form was purely a matter of thought in the designer. He proposed to consider what ornament was, what it meant, and what made it good or bad.

Ornament may be defined as design added to any object in order to increase the beauty of that object, and this definition would exclude from their consideration all artistic designs which were sufficiently attractive to be regarded as separate pieces of decoration. Thus on the wall was a Japanese landscape—a very bad one, regarded as a landscape—but still it could not be regarded as mere ornament. This led them to the conclusion that ornament was relative; that its value must not be judged by its own merits, but in reference to the object to which it was applied, the suitability of the material in which it was executed, and the shape of the surface on which it was placed.

Thus it was necessary that ornament should appear evenly to fill the space which it occupied. Ornament might be applied in two ways, as surface and as functional treatment. In the former case it was put upon an expanse of surface just to give it more interest than it otherwise possessed; in the latter case it was so applied as to emphasize certain parts of the object decorated. Among the examples of functional ornament shown were the rings on the neck of an Egyptian jar, the band of color around the eye of a parroquet, and the lines of color defining the edges of the wings of butterflies. Another two-fold division of ornament related to the forms employed—abstract and natural. The first class were all those forms which did not imitate any object found in nature, and to this belonged all purely geometrical designs. All the forms of ornament in the second class were more or less directly imitated from nature, and the extent of this importation would be an important point for consideration.

There was yet a third class of ornament which could be dismissed in a few sentences, as it was always bad—that derived from artificial objects. Reverting to the consideration of abstract ornament, it was apparent that to be worthy of the name it must show in itself evidences of design, and of having been intended to fill a certain space. Suppose a given surface was required to be filled with ornament; if circles were drawn upon it at irregular intervals no pattern would be produced; but by arranging them in regular order a certain amount of pattern was given, which could be rendered more satisfactory by shifting and alternating portions of the circles, and fitting all in closely to fill the space. Ingenuity and thought should be employed in designing ornament, so that all the elements of a design could not be grasped by the eye at once.

The same process could be followed in straight-line designs, and by a slight shifting of the parts the square key fret was produced, which, originally invented by the Greeks, had since been popular among many nations, and was very freely used by us on all sorts of objects, for example, in first-class railway carriages. Through the greater part of the various forms of ornament employed there ran a principle of duality, and examples of similar abstract patterns could be found in parts of the world which could have had no connection with each other during many ages—among the Greeks and the South Sea Islanders. The use of intercepting lines based on the square was almost universal; it was found among the Egyptians in a crude form, with greater refinement among the Greeks, with more twisting and a use of the diamond shape in Celtic races.

Among the Arabs and Moors the diagonal lines and the hexagon were the favorite geometrical patterns, and no nation had employed these forms with such cleverness, ingenuity, and brilliant effect as the Moorish artists, although after attentively drawing and studying their work, one lost respect for them, and realized that their skill had been overrated. Most ornament of the abstract class was capable of analysis into simple geometrical forms. The second class of ornament, the natural, was based on imitations of the forms of nature. Upon this branch of the subject there was a great deal of misunderstanding. There should be no attempt at direct copyism. The man who closely imitated a bunch of flowers was painting flowers, and not producing ornament; he ought merely to use natural objects as the basis of suggestions, and then arrange these derived forms so as best to occupy the space to be ornamented.

In utilizing natural objects for this purpose the characteristic and essential features should be seized and emphasized, and the merely accidental ones left out. Thus, in the choice of a nasturtium flower for ornamental purposes, the leading idea should be that there are six leaflets disposed from a center, with curved sides slightly overlapping; if the object ornamented was a tile, the outlines of petals and flowers could be thickened, and the twisted form of each petal made more marked and regular. So the leading principle in an ornament based on the nasturtium leaf would be a nearly round outline, with a radiating group of ribs, starting from an eccentric point. The nation who carried out this principle of selection and adaptation to the highest perfection were the Greeks, and in their ornament one found little more than a trace of natural life.

Let them take the acanthus leaf for instance—a prickly, curved, irregular form—and see how it was systematized without losing its graceful curves, until it was rendered exactly suitable for reproduction in the fine, sharply cut lines of marble. Italian ornament was partly based upon Greek lines, but was much more naturalistic; and although often very elegant, fell short of its aim in just so far as it became imitative art. In some instance of Indian carving on capitals again, the result was unsatisfactory, as it failed either to represent the plant or to be good ornament, and was merely a clumsy attempt to carve a leaf on the block of stone without special endeavor to cover the surface. The Early Gothic forms of foliage, with their rounded masses, were just as suitable for treatment in our softer stone as was the acanthus for marble. In Early French work the same characteristic ideas were apparent. In our later Gothic carvings the ornament lost its feeling of growth and vigor, and just as it became more directly imitative of nature, and more distinctly appliqué decoration, it failed in its purpose. In the earlier work of the Italian Renaissance, there was much of the old Classic force and character, but it would be seen by the casts on the table that it soon lost this strength, and fell into littleness and prettiness of effect. Another point in which Greek carving showed its superiority was in the purity and beauty of its curves; all the lines were clean and always tangential.

In Roman work, they not only saw vulgar copyism, but the curves were lost in heavy, cabbage-like forms. Some Indian work came a great deal closer to nature than any other style, and yet in many classes of ornament retained a vigorous character. In textile fabrics a greater amount of direct imitation of nature was permissible than in other forms of art, because from the very nature of the material a very close approach to copyism was impossible. Many of the designs in their shawls and other fabrics were admirable, but would not be satisfactory if carried out in inlaying. One form of ornament, he had said, was always bad—namely, the imitation of artificial objects. In most cases, the object forming the basis of adaptation possessed neither interest nor beauty in itself, and the ornament showed absolutely no thought. Even the Greeks used one form of this kind, the skulls of oxen, with festoons of garlands on their temples; but here, as indicating the sacrifices offered within the building, the device had some meaning. These swags were constantly applied where they had no purpose; and although in the Adams style they were often used with some refinement and prettiness, they were at the best inappropriate. Returning to the consideration of functional ornaments, he would find out that it ought always to follow the lines of, and emphasize, the leading points of the object to be ornamented. In this respect Japanese ornament, now so popular, failed, as it was merely splashed on to the surface treated, without any attempt at regularity or system. The striations on a Greek column, emphasizing the verticality of the feature, formed an admirable illustration of functional ornament, and so did the foliage of capitals and treatment of vases among the same nation. Even Greek ornamentists were not always successful, however, and the lecturer showed a drawing of a vase in which the springings of handles were ignored in the scheme of ornamentation. It would be easy so to treat the base of the handles as to give grip and importance to them.

Ornament was always misapplied on the part of an object in constant use, as the handles of a sedan chair or a jug. The nature of the material and use of the object must be considered. Thus, a reticulated key pattern was suitable for a block or tile floor; but any attempt to represent patterns in perspective on a floor, as in a Pompeian example shown on the screen, was inappropriate and unpleasing. Ornament must not contradict the great physical laws; foliage should not be represented as growing downward instead of upward, nor should a stem appear too slight for the masses it had to support. A flagrant error of this class, common in Adams work, was the representation of festoons on ceilings. The question arose, how far might the human form or those of animals be introduced into ornament? The human form should be employed as little as possible, and where it had to support weight, as in the sphinxes of Egyptian art and the caryatides of the Greeks, all character and vivacity should be taken out of the figure, or the effect would be painful.

The ornamentists of the Renaissance period erred greatly in this respect, from their love of displaying the human figure, and introduced faces and figures into scrolls. Although the forms of animals might be employed with less restraint, yet the use of animal shapes for vessels was very vulgar. This form of vulgarity had been extensively used among many nations widely separated from each other, and when Ruskin some time since uttered a violent prophecy as to the degradation that was coming upon England because a butterboat had been made in the form of a cow, he overlooked the fact that it could be paralleled in all ages and among every nation.

It was a difficult thing to use ornament which had a distant purpose in it; in proportion as it had a meaning in it, it often ceased to be beautiful. The winged orb of Egyptian art was one of the few forms of a sacred emblem satisfactorily used as ornament. Too often modern ornament, where it attempted to give expression to the purpose of a building, was incoherent and unsightly. One of the exceptions to this rule was found in M. Garnier's new Opera House at Paris, where a winged lyre was treated effectively. Another danger to be guarded against was the use of ornament in contradiction to constructional lines.

A fashion had sprung up of late years of decorating the panels of doors in Queen Anne houses with naturalistic sprays of foliage continued from one to another without reference to the intervening frames. Apart from the curious mixture of Japanese and Queen Anne styles it involved, this was constructionally wrong, for it implied that the door consisted of a large but thin panel over which a thick frame had been placed; whereas the framework was the essential feature, and the panels were mere boarding in the interstices. If the panels must be decorated with foliage, each should be distinct, and the framing should be emphasized by straight lines or flutings running horizontally or vertically in the direction of the fibers of the wood. There was style and there were styles in ornament, it should be remembered, the words being used in different senses.

Ornament was spoken of as in different styles, Greek and Roman, Gothic and Renaissance; but style was something apart from these, and might be defined as a general, pervading homogeneity of idea in the mind of the designer as to the forms he intended to use, and as to the method in which he proposed to work. Style and no style could be illustrated in two examples, one from Richardson's "ornament," in which the designer seemed to have no idea of what he meant to do, or how he should occupy his space, and the other from a foliage cap of Early Renaissance character by a modern French architect, in which character, breadth, and originality were evident. In conclusion, Mr. Statham urged the value and desirability of knowing good and bad ornament when we saw it, and of recognizing why it was good or why bad, not only for its own sake, but as a form of mental training and discipline.

POITRINEAU'S MOVABLE BUILDINGS.

WE have recently had an opportunity of seeing the different models of movable structures that have been devised by Mr. V. Poitrineau, an expert architect, and the system seemed to us to be so ingenious and capable of proving so

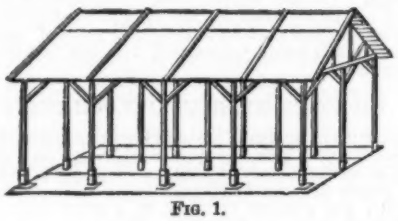


FIG. 1.

useful in a great number of cases, that we have thought it our duty to give a description of it.

The object that the inventor has had in view is to do away with the necessity of demolishing and reconstructing temporary buildings, by substituting structures therefor whose

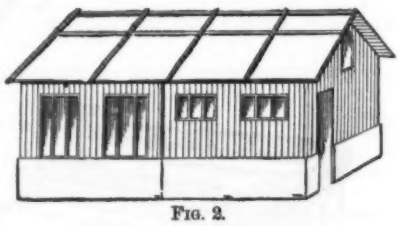


FIG. 2.

different parts have been made in advance and may be easily put together and taken apart.

The system may be readily understood from the accompanying figures. Fig. 1 represents a shed which, at first sight, resembles an ordinary framework construction; but it is nothing of the kind. The posts which support the

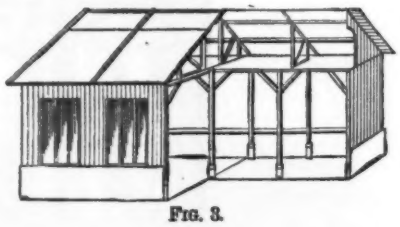


FIG. 3.

structure rest upon small cast iron jack-screws, the purpose of which will be explained further along. Boarding, prepared in advance, when applied to the sides of this shed converts it into a small, absolutely tight house (Fig. 2).

This little house is divisible into four separate compartments, as shown in Fig. 3, where one of the compartments has been removed.

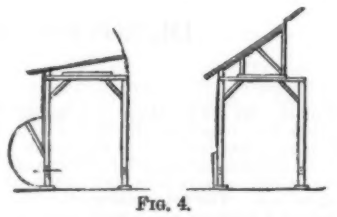


FIG. 4.

The house having been put together, suppose we wish to transport it elsewhere. We begin by letting down the four portions of the roofing, the frames of which are hinged near the eaves. Fig. 4 shows, to the right, the roof raised, and, to the left, lowered. These roofs are made as light as possible, and consist of frames of wood covered with sheet

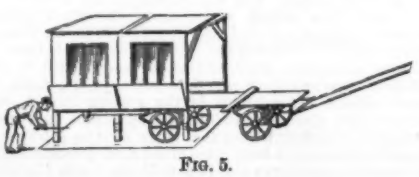


FIG. 5.

zinc. The base boards, which form an offset around the building, are likewise hinged, and are raised as shown in Fig. 5.

Each part of the structure may be placed upon a wagon and drawn by a single horse (Fig. 6). The operation of loading can be performed by one man by aid of the jack-

FIG. 6.

screws. When the compartment reaches its destination, each jack-screw is placed beneath its post, and one man again raises the structure, disengages the cross beams, and lets the whole affair down again and levels it after removing the wagon from under it. The same operation is gone through with with all the compartments, whatever be their number; and they are juxtaposed according to fancy and connected by

a few bolts. The roofing is reconstructed by raising the frames and supporting them by trimmers.

The type of construction that we have above considered (Figs. 1 and 2) may serve at will either as an open shed or a closed house, the transformation from one to the other being effected by means of boarding, windows, doors, etc., all made after the same model, and which may be ordered from the constructor. If the shed be used (Fig. 1), it may also be converted into a stable, workshop, etc., by means of special compartments.

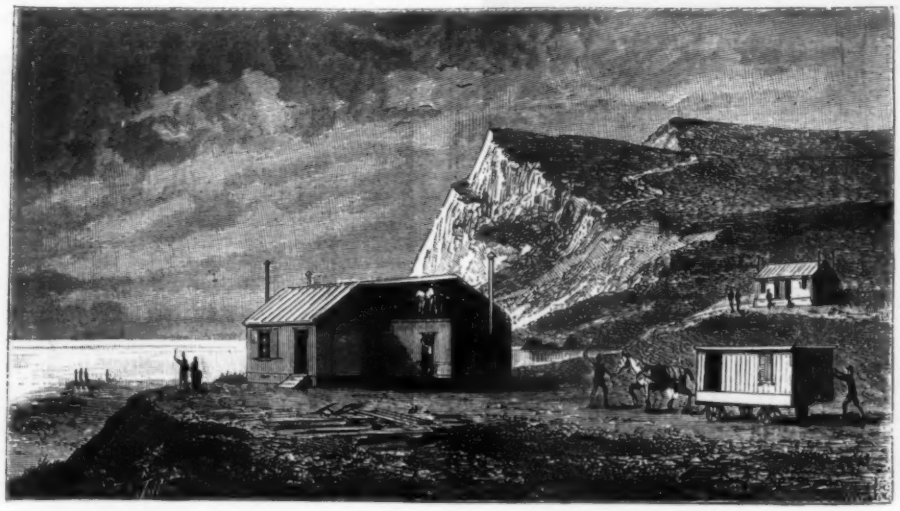


FIG. 7.—CONSTRUCTION OF A SEASIDE COTTAGE.

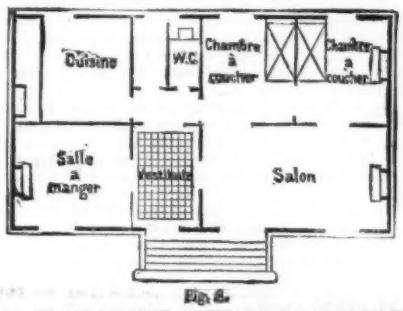


FIG. 8.—PLAN OF THE COTTAGE SHOWN IN FIG. 7.

Mr. Poitrineau has combined a complete series of structures of every nature, which are all formed of parts made after a definite model and capable of being easily combined with one another. The system may be advantageously applied (among other purposes) in the construction of sea-side cottages, and, when the point of view where the owner has fixed his residence ceases to please him, he can transport his house and household goods elsewhere. If the dwelling is too small, a guest chamber may be ordered, and this will be at once sent by railway. Some of the siding having been removed from the house, the new compartment is added, and there you have the guest chamber. The number of compartments may thus be increased *ad infinitum*.

Fig. 7 shows a type of cottage suitable for a sea-side habitation, telegraph station, shooting box, etc. It is represented at the moment when the fourth compartment is about being affixed to it. The plan in Fig. 8 shows the interior arrangement of the cottage, which, as will be seen, includes two bed rooms, a parlor, a dining room, a kitchen, and a vestibule. We must not forget the garret, which is formed

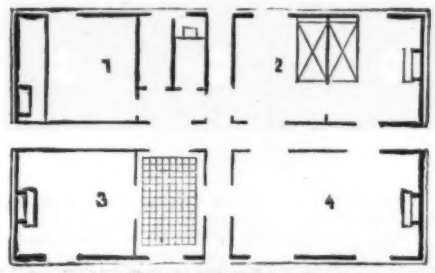


FIG. 9.—PLAN OF THE FOUR SEPARATE PARTS OF THE COTTAGE.

by the sloping roofs, nor the cellar, which consists of two excavations in the ground beneath.

Fig. 9 shows the four parts of the house separated and ready to be carried elsewhere. Arrived at the new location, the four compartments, which in this case are mounted upon wheels, are juxtaposed in pairs, bolted together, leveled by means of their jack-screws, and their roof raised as above described. This operation takes but 20 minutes and requires two men to each compartment.

The side walls are hollow and allow the air to circulate during summer, but upon the advent of winter they are filled in with sand, and the orifices beneath are calked up. —*La Nature.*

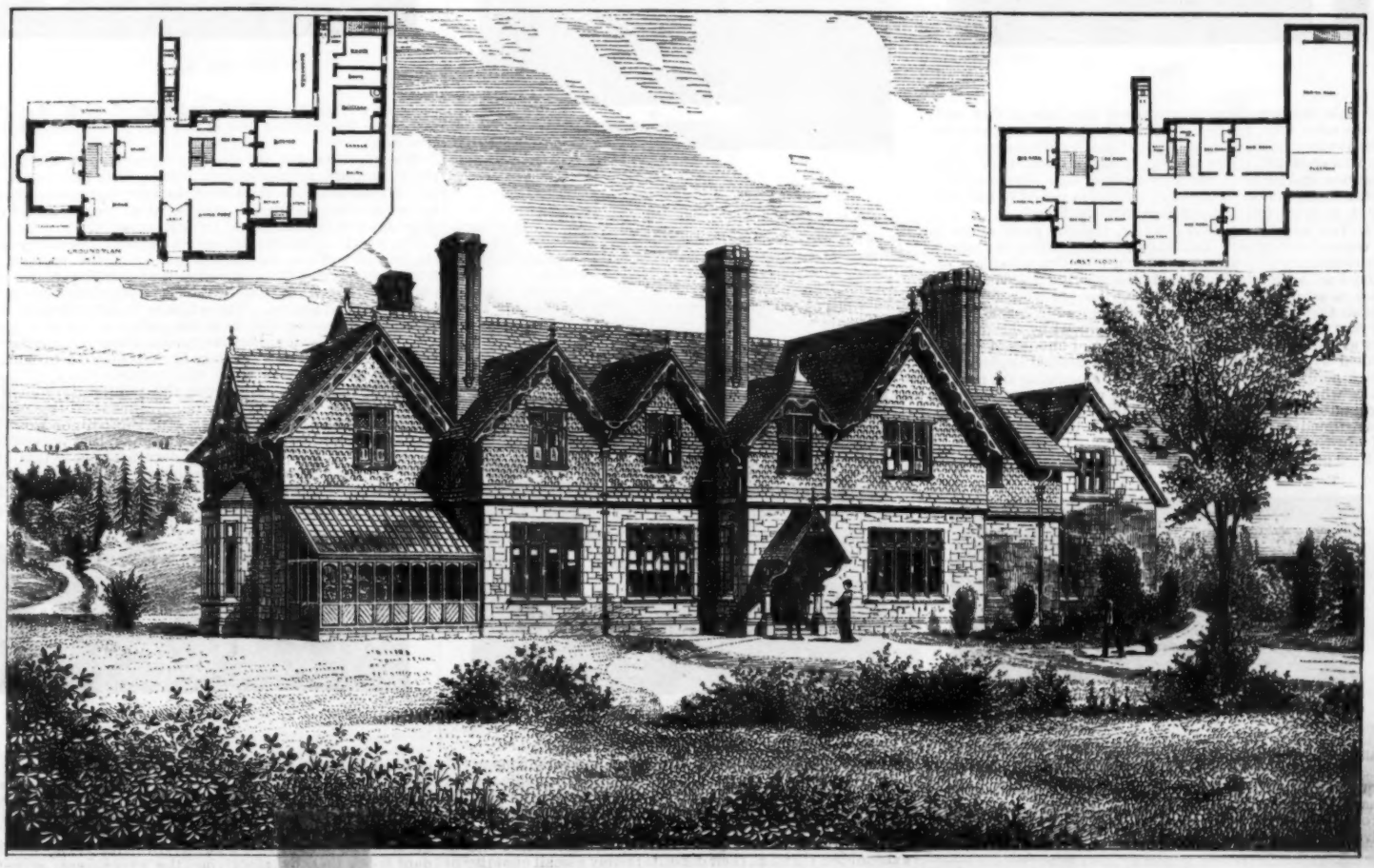
LLANDRINDOD WELLS RECTORY.

AMONG the many improvements that are being carried out at that popular Welsh watering place, Llandrindod, Wales, is the erection of a new rectory for the Ven. Archdeacon D'Winton, rector of the joint parishes of Cefullys and Llandrindod. We publish an illustration of it showing the east front. The contract has been taken by Mr. Williams, builder, Knighton, Radnorshire, and the works are now in progress. Its walls are built of Trefinon stone, from near Talgarth, Breconshire, with Boxground stone for dressings to level of first floor; above that level they are to be built of local brick, hung with red Broseley tile, and nailed to battens. The roofs will also be covered with Broseley tiles; the chimneys will be built of best pressed red bricks. Mr. S. W. Williams, of Rhayader, county surveyor of Radnorshire, is the architect. The contract, including stables, coach-house and out buildings, is £3,000.—*Building News.*

THE COMPARATIVE VISIBILITY OF ILLUMINATED SURFACES.

M. AUG. CHARPENTIER has communicated to the *Comptes Rendus* a "Note" upon the visual perception of differences of illumination. M. Charpentier's researches were directed to the investigation of the differential sensibility of the eye, in relation with the degree of illumination, and also with the size of the illuminated objects. The instrument used in these experiments consists of a translucent screen placed at the bottom of a dark box. This screen is arranged to be lighted simultaneously in front and behind, by means of two independent light-sources, each being susceptible of variation in power at will. One of these lights is behind the screen, and the other is before it on one side; the light being directed on to the screen by means of an inclined mirror. Thus the face of the screen may be lighted by varying degrees of light, capable of being exactly measured. Moreover, the other luminous source may be employed to light up from behind, with varying intensity, a spot of any determined size on the screen. It is therefore possible in this way to ascertain the exact amount of extra light which it is necessary to throw upon the small spot, in order to distinguish it from the remainder of the surface of the screen. Under these conditions, M. Charpentier has found that the classical law according to which the *differential fraction* (the ratio of the extra lighting to the brilliancy of the rest of illuminated field) should be constant, whatever the absolute luminous intensity, is wholly wrong. Aubert showed, twenty years ago, that the supposed differential constant is greater when the illumination is less, and, in the course of one experiment may vary from one sixty-fourth to one thirty-fifth for the same observer. M. Charpentier has seen the variation even more marked than this; so that, generally, he confirms Aubert.

M. Charpentier has also studied the influence of the size of objects upon the power of perception of differences in luminous intensity. This influence is very considerable; especially when the objects are small. For visual angles below 30', the differential fraction appears to be inversely proportional to the diameter of the object to be distinguished; the influence of area is less, although the same in kind, when the objects are larger. The influence of the degree of lighting upon the power of appreciating differences depends upon a more complex law. Many of M. Charpentier's observations may be expressed by the following formula: The differential fraction (minimum of difference preceptible) is



SUGGESTIONS IN ARCHITECTURE.—LLANDRINDOD RECTORY, WALES.

inversely proportional to the square root of the intensity of the luminous screen. Some experiments more or less transgress this rule, without apparent cause; but in every case the diminution of the illumination acts in the sense indicated. By combining these two conditions, of a very small object with very feeble illumination, M. Charpentier has obtained astonishing results, even to one day being unable to distinguish from the screen a point nearly ten times more luminous. It was an extreme case, of a point 0·0005 meter in diameter; but between this fact and others, when it was possible to distinguish surfaces differing in luminosity by less than one one-hundredth, it was easy to trace a series of intermediary examples.

These results of M. Charpentier's experiments are so remarkable, from the point of view of the practical photometrist, that their investigation appears to be an immediate necessity. For if M. Charpentier's conclusions are correct for the range of luminous intensity ordinarily comprised within photometrical observations, it is manifest that the generally received ideas relating to the size of the spot on the illumined disk, as viewed by varying degrees of light, are erroneous. It has been proposed to substitute, for the present double-candle standard, a single pentane-gas flame normally equal in brilliancy to one candle. This reduces the illumination of the disk and spot by one-half; and it becomes a question, after what M. Charpentier has said, whether the same sized spot is capable of yielding similar indications under these different conditions. Again, with the 16 candle sperm lamp introduced by the late Mr. Keates, the same disk and spot are observed under a correspondingly brighter light on both sides. Does M. Charpentier's result apply to the case of the ordinary photometer screen under the diversity of conditions here described? He would have us believe, as the general principle, that differences of brilliancy in the spot and screen are less readily visible by the light of the smaller than of the more powerful standard, in the proportion already named. It is evident that if this law holds good within the before mentioned limits, the ordinary photometer screen and spot will need modification with every varying standard. Beyond this, the discovery, in so far as it has any influence upon practical photometry, appears to be against the use of feeble standards. For these reasons, it is advisable that M. Charpentier's experiments should be checked by independent observers.

UPON SOME FIGURES OBTAINED BY MR. CARDANI THROUGH ELECTROLYSIS.*

If we operate the electrolysis of a solution of nitrate of silver spread in a thin stratum upon an insulating plate (of glass, for example) by means of electrodes formed of strips of platinum resting upon the plate, we shall obtain at the negative pole curious crystalline ramifications of very pure silver, in the form of dendrites, which, as a whole, recall in

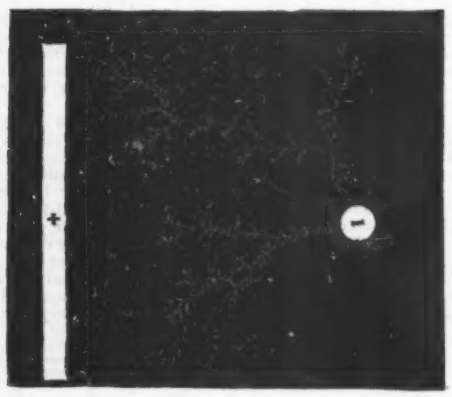


Fig. 1

a certain measure the arrangement of the lines of flux, and, at the same time, present a certain analogy in form with the positive ramifications that are produced by discharges upon insulating bodies. The analogy between these silver ramifications and those of the positive discharge even continue when the arrangement of the electrodes is varied in different ways, as is proved by the following experiments:

1. The negative pole is circular, and the positive one is a rectangular plate. In this experiment, as in the others, the electrodes used are of platinum. The ramifications obtained are shown in Fig. 1. At the positive pole there likewise deposits a black substance, the peroxide of silver, which also produces ramifications in certain cases, although of very different form from those produced by the pure silver at the negative pole, and consisting of bundles of needles united with each other at very sharply defined angles. This black peroxide served the author for recognizing the positive poles when he was passing different currents into the electrolytic stratum. Yet he remarks that in most cases he often interrupted the ramifications in order to allow the deposit of silver to form more at leisure.

2. The two electrodes are square. Fig. 2 shows the

Fig. 2.

ramifications obtained in this case. They start, as will be seen, exclusively from the different corners of the negative square. Fig. 3, in which this property of the points is very marked, was obtained by means of square negative electrodes placed between two plates connected with the positive pole. This event, however, might easily have been foreseen as a consequence of the distribution of the current. In fact, the lines of the current's flow in a given plane, with certain electrodes, are identical with the lines of force of two parallel conductors whose sections are equal to the electrodes in question. Now we know that, in the case of an electrostatic equilibrium, if one of the conductors is provided with edges like a prism, whose section is represented

Fig. 3

by the square employed in the preceding experiment, the electricity will betake itself by preference to the edges whence the lines of force diverge in great number. Consequently, even in the case of this experiment, the crystallizations should occur by preference upon the angles where the lines of the current's flow must be most numerous.

Fig. 4

3. We place, between the two square platinum electrodes, a third square one, also of platinum, but insulated in the liquid (as in Fig. 4), so that six corners of three squares are in a right line. If A B is positive and E F negative, we shall see the pure silver ramification form at E, and the black peroxide one at B. At C D, where the current flows from C toward D, two ramifications form—at C a crystalli-

Fig. 5.

zation of silver analogous to that at E, and at D a black one of the same form as that at B. In other words, the conductor, C D, behaves just as does a body submitted to the influence of an electrified bdy in static electricity.

An analogous phenomenon occurs in case several conductors are placed separately along the line of the currents flow.

4. The action of several electrodes in the electrolytic

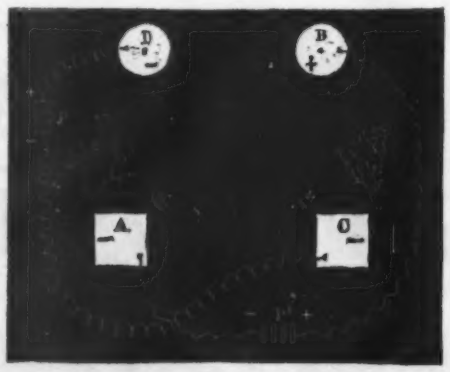


Fig. 6.

plane considerably modifies the form and arrangement of the crystallization. Thus, if we take two small spindle-shaped platinum rods, and put them in communication with the negative pole, the positive pole being formed of a rectangular plate, we shall observe the effect shown in Fig. 5. From the extremities A and D, start the crystallizations, while at extremities, C and B, their deposits merely a small quantity of the heaped up silver as in the distribution of the lines of force between two conductors charged with equal electricity

5. In this experiment the author took two distinct currents. The two negative poles were square, and the two positive ones were circular. The four poles formed the extremities of a square. Since C is nearer B than, D, and A is nearer D than B, the two piles really constituted a single one, which was interrupted by two electrolytic vessels. The total current from the piles, P and P¹, going from B to C, and from D to A as if in a single electrolytic trough, two were obtained as in Fig. 7. A similar phenomenon would be obtained in static electricity with four parallel

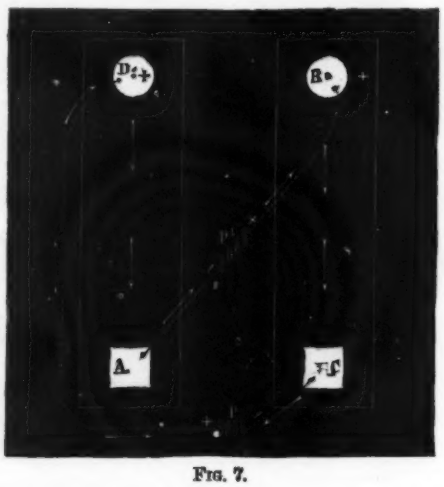


Fig. 7.

conductors, of which A B C D were the sections, and which were put in communication with the armatures of a condenser, A (negative) and B (positive), and with the armatures of another condenser, C (negative) and D (positive). The lines of force that started from C, would nearly all of them direct themselves toward B, and a few of them toward D, if B were nearer D.

6. An analogous result is obtained by arranging the poles of the two piles at the extremities of a rectangle, so that the poles of one pile are upon one of the larger sides of the rectangle.

In Fig. 8 the poles of one pile are at A and B, and those of the other at C and D. The ramifications form from D toward A, and from B toward C, as if the two piles were separated by two electrolytic vessels in one of which were the electrodes, A and D, and in the other the two electrodes, C and B.

7. Finally, the author arranged the poles of the two piles upon the same line and alternately, so that the positive poles of the two were at the extremity, and the negative ones in the center. In Fig. 9 the poles of one pile were at A and those of the other at C and D. The ramifications formed by

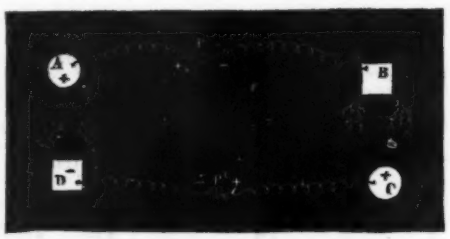


Fig. 8.

preference from A toward D, and from C to B, that is to say, from the negative pole of one pile to the nearest positive one.

This experiment is explained by supposing the electrolytic plane divided into two by an insulating layer between A and C. We should have likewise in this case two piles separated by two electrolytic troughs, and the total current would have to go from D toward A and from B toward C.

The beauty of the crystallization depends essentially upon the intensity of the current and density of the solution. If a solution too rich in nitrate of silver be employed, we shall obtain large scales instead of the crystallizations represented in the annexed figures. These figures do not appear to have presented any other interest to the author than that of pretty well resembling the positive ramifications of discharges; so he has not judged it proper to introduce them into his memoir.

Despite this analogy between the ramifications obtained and their behavior and the ramifications of the positive discharge, and notwithstanding that Prof. Righi has demonstrated that the latter represent in general the lines of force of static electricity, Mr. Cardani does not think that there are any plausible reasons for believing that the silver ramifications represent the lines of the current's flow. In fact, the deposit of silver by electrolysis that forms at the negative

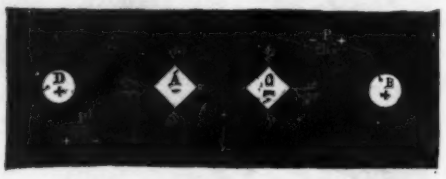


Fig. 9.

pole constitutes a prolongation thereof, and, consequently, in the course of the experiment, the form of the negative electrode, as also that of the lines of flow and the lines of level, must change. Meanwhile, notwithstanding the failure of a few experiments made in order to obtain an exact diagram of the lines of flow with silver ramifications, Mr. Cardani hopes that, by modifying the experiment, either by diminishing the duration or regulating the intensity of the current, he will succeed in obtaining that result.

* From *La Rivista Scientifico-Industriale*, after *La Lumiere Electrique*.

Other liquids, such as solutions of sulphate of soda, nitrate of lead, etc., give analogous figures, but ones that are, in structure, very different from the dendritic forms yielded by nitrate of silver. Copper especially gives rich ramifications which have continuous curves at their extremities, and which in the parts opposed to the electrodes greatly resemble equipotential lines. The author proposes to treat of this question in a later memoir if his experiments yield him results that are of any interest.

DR. WREDEN'S MICROPHONE TRANSMITTER.

To the International Exhibition of Electricity at Vienna Dr. Wreden brought from Russia a whole cargo of transmitters, his collection comprising no less than forty-eight different styles of them.

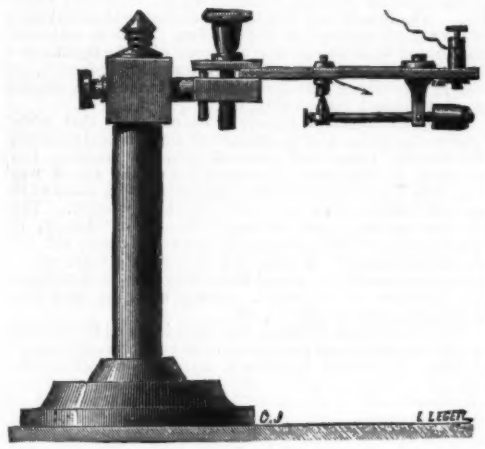


FIG. 1

We have made numerous experiments with these apparatus, and the results thereof have much exceeded our expectations.

In form (Fig. 1) the Wreden transmitter recalls a model that was experimented with a long time ago by Hughes, and by him abandoned. Contact is formed between two pieces of carbon, *a* and *b*, the latter being fixed to the extremity of a small lever, I, which is balanced by a counterpoise, G. Regulating is effected by moving backward or forward the small weight, G, which is screwed to the lever. A set-screw, D, maintains the regulation.

In the model shown in Fig. 1 the support is a plate of ebonite 8 centimeters square, which is itself supported by a nickel-plated copper standard.

Speech is reproduced with remarkable clearness, and quite loudly.

The current is furnished by a single Doliva-Dobrowolsky

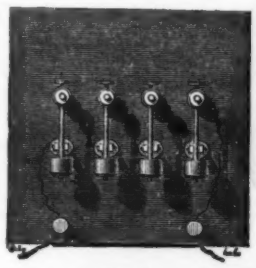


FIG. 2.

binoxide of manganese and sulphate of ammonia element. Induced currents are produced by means of a small induction coil, and are received in a Goloubizky receiver.

Fig. 2 represents a four-contact model, the four contacts being in tension. The support is of cork, and the foot or standard is the same as in the apparatus just described. With this arrangement the results exceed in intensity anything that we have heard of up to the present time.

A large Siemens apparatus is employed as a receiver, this being furnished with a speaking-trumpet of the style used by Mr. Ader. Speech was heard at several meters distance from the apparatus, notwithstanding the noise that prevailed in the Rotunda, and every word was distinguished perfectly. The intensity was that of the ordinary voice. Although the four contacts were in tension, there were no sputtering sounds. We did not ascertain by what means they were got rid of. The sounds from a music-box that was held above the transmitter were heard at a distance of more than ten meters from the telephone.

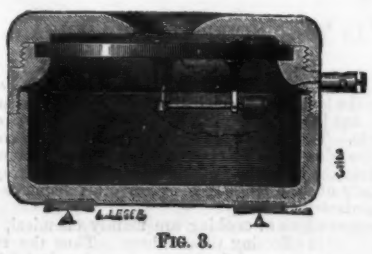


FIG. 3.

We repeat it, these were results that were not to be expected from so simple an arrangement, and it would be difficult to explain the cause thereof. It must be due in great part to to the regulating, which is delicate, but which is happily very well kept up.

Dr. Wreden also arranges his transmitter in a round box, and in this case it appears as in Fig. 3. Three circular pieces of cork, A, permit of placing the apparatus upon a table for speaking purposes. External vibrations are thus overcome, but the apparatus may likewise be held in the hand. When the speaker is through with the apparatus the box is turned over, mouth downward, when the lever tilts and the current from the pile is broken. Speech is here again well reproduced, and there are no sputterings.

In addition to the above there were exhibited several large boxes with 3, 9, and 12 carbons. We experimented only with those of 3 carbons, and which required two elements. Here it was the voice that was admirably reproduced.

A large quantity of curious forms of the apparatus was exhibited. We reproduce one of the most original of them in Fig. 4. This is an ordinary wine-glass, whose bell-shaped form is perfectly adapted to the reception of sonorous waves.

We must likewise make mention of the Wreden apparatus designed for divers. This consists of a box analogous to the one shown in Fig. 3, and provided with a leaden bottom,

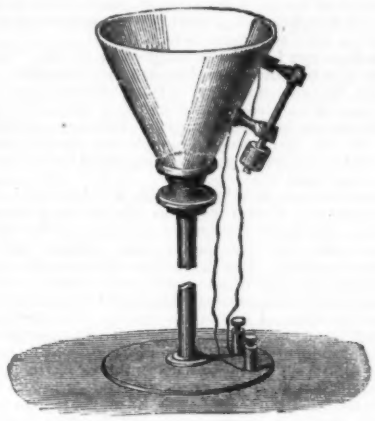


FIG. 4

FIGS. 1 TO 4.—DIFFERENT FORMS OF THE WREDEN TRANSMITTER.

This the diver carries suspended from his neck. We have transmitted speech very well on immersing the apparatus shown in Fig. 1 in a basin of water. This experiment was performed in order to show the possibility of operating the diver's apparatus.

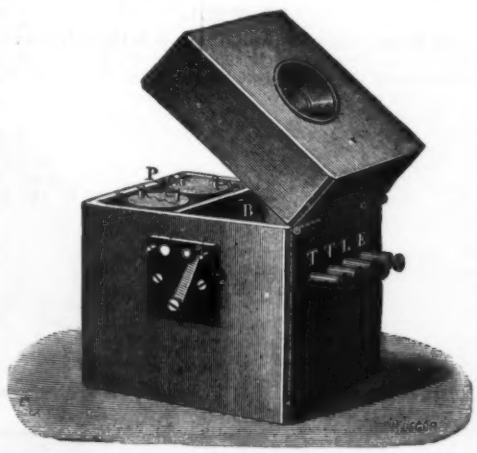


FIG. 5

FIG. 5.—WREDEN TRANSMITTER, WITH CALL BELL.

There were likewise exhibited complete station apparatus that had the somewhat heavy appearance shown in Fig. 5. In the cover of these there is a single-contact transmitter having a sheet of cork fixed solely on one side. The current enters through the two hinges, G. In the box there are two small Doliva elements, P, and in the compartment, B, an induction coil and a vibrating bell. The latter serves for

FIG. 6.—DIAGRAM SHOWING THE COURSE OF THE CURRENTS.

calling, and is set in operation by pressing the lever, M, to the left. In a central position the apparatus is at rest, but the telephone is capable of receiving the call. In order to speak, the lever is pushed against the stop to the right. The four terminals (which are reproduced in the diagram in Fig. 6, showing the course of the currents) are lettered T, T, L, and E. B is the induction coil, the fine wire of which is connected with the terminal, E (earth), and the terminal, T (telephone). The telephone is constantly in the circuit of the line. The transmitter is at A. It will be seen that in putting the lever, M, of the commutator, G, upon the contact, *l*, a single one of the elements will be interposed in the primary circuit of the bobbin. On the contrary, in order to set the bell in operation, two elements are employed, these being interposed in the circuit by uniting the two contacts, *m* and *n*, by the metallic piece, K, which is insulated from the lever, M. The call is sufficient, and may be heard throughout an entire room without any necessity of adapting a trumpet to the telephone.

The advantages that Dr. Wreden claims for his system are as follows: Cheapness, constancy in regulation, compactness, and excellent performance. In spite, however, of the brilliant experiments that every day attracted the attention of a crowd of people, the actual value of this receiver cannot as yet be pronounced upon, for it must first be seen how it will work on a line.—*P. Samuel, in La Lumiere Electrique.*

NEW MODELS OF ACCUMULATORS.

UNDER directions from Mr. Emile Reynier, Mr. A. Simmen has just got up three models of secondary piles, which appear to be quite compact. The Plante type (Fig. 1) contains three lead electrodes, all alike. Each of these consists of a long and thin sheet folded and soldered at its upper part to a piece of brass which is fixed to a paraffined wooden support. The central electrode, P, is the positive one. The two lateral, negative ones, N N, are connected with each other outside of the vessel containing water acidulated with sulphuric acid. The entire apparatus weighs about 27 pounds.

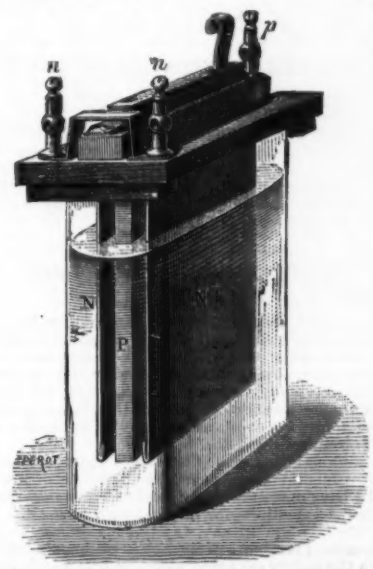


FIG. 1.—REYNIER-PLANTE ACCUMULATOR.

The *copper* accumulator (Fig. 2), which has nearly the same aspect externally, weighs but about 15 pounds. It is mounted with a positive central electrode, P, of folded lead, *formed* by the Plante process; but its lateral, negative plates, N N, are smooth sheets of lead coppered by the electrolysis of the acid solution of sulphate of copper contained in the glass vessel.

The *zinc* accumulator differs from the preceding only in the substitution of sulphate of zinc for sulphate of copper. The capacity for accumulation is the same in each of the three models—about 125,000 coulombs after a thousand hours of formation.

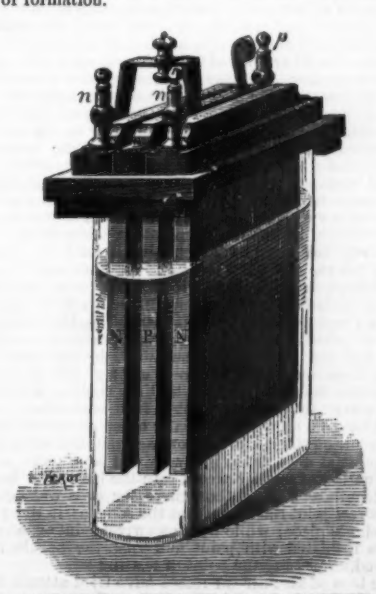


FIG. 2.—REYNIER'S ZINC-LEAD OR COPPER-LEAD ACCUMULATOR.

The zinc pile loses much by the local attack of the zinc, so it is proposed to make it serve as a voltametric regulator. As accumulators, properly so called, the two other models are to be preferred.—*L'Electricien.*

MODIFICATION OF THE LECLANCHE BATTERY.

M. BLEUNARD uses plates of zinc and carbon, both immersed in a saturated solution of potassium bichromate and of ammonium sulphate or hydrochlorate. To prevent the ammoniacal salts from climbing up the carbon it is previously steeped in a bath of boiling paraffin, and its surface is then scraped with a knife.

TRANSLATION OF THE MORSE TELEGRAPH SIGNS INTO LETTERS.

THE very ingenious key that we present herewith has been devised by Commander Perein for immediately finding the letter that corresponds to the signal of the Morse system. In this system, as well known, the letters are represented by a definite combination of dots and dashes. Thus, *e* is represented by a dot and *t* by a dash, *a* by a dot and a dash, and *m* by two dashes, and so on. These combinations have been selected in such a way that the simplest of them correspond to the letters most frequently employed; but, as such frequency is not commonly known, it follows that the memory has trouble to retain the correspondence of letters and signs, and beginners are obliged to have recourse to two different tables wherein they are classified in alphabetical order. Commander Perein's method has the dvantage that it unites the two tables into one. A little study will suffice to make it understood.—*La Nature.*

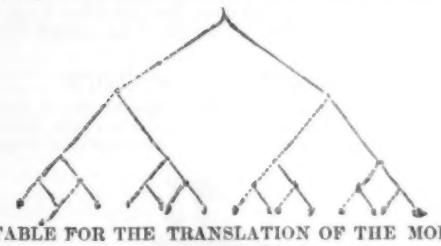


TABLE FOR THE TRANSLATION OF THE MORSE ALPHABET.

MAGNETIC POLARITY IN IRON.

To the Editor of the Scientific American.

In the issue of the SCIENTIFIC AMERICAN for January 19, 1884, I have read with much interest an editorial article entitled "Magnetism in Cities." The writer notes several curious facts concerning the magnetism of iron structures in New York city, and assumes or infers that the magnetic qualities observed are due to the fact that the structures experimented on "are constantly subjected to shocks and vibrations produced by traffic."

Now, although this is the first time I have seen the facts referred to mentioned in print, they have been familiar to me, and I have made the experiments mentioned—and many others in the same line—for the past ten years.

The only mention in any way bearing upon the subject that I *have* seen is a short paragraph in Silliman's "Physics," in which the author says that pieces of iron which for many years have stood nearly upright, and in the magnetic meridian, acquire a fixed polarity—the upper end being south and the lower end north. He instances the tongs which for many years have stood upright in a farmer's kitchen.

The results of my own experiments, made with a small pocket compass in a great variety of places and under all sorts of conditions, is this, and, so far as I know, the discovery is my own:

All masses of iron, whether large or small, and of whatever shape, possess a north and a south magnetic pole; dependent entirely upon their position relative to the earth. Whichever end or side is for the time being *up* is a *south* pole, and attracts the north pole of a compass; whichever end is *down* is a *north* pole, and attracts the south pole of a compass.

The only exceptions I have found is this, that a bar of iron which for many years has stood in a perpendicular position (without any reference to inclination or magnetic meridian, as Silliman seems to indicate) acquires a fixed polarity, becoming in fact a magnetic needle of itself.

As examples of this great general law, I have tried the compass on all sorts of iron work and pieces of iron, and find that whichever end is up for the time being is a south pole; but immediately changes to a north pole upon the iron being reversed. In all articles of iron—stoves, safes, pillars, steam radiators, anchors, etc., the center of gravity is the dividing line. Below that the south pole of the magnetic needle points to the article; upon raising the compass the attraction grows weaker, until the center of gravity in the article experimented on is reached, when the needle immediately reverses and its north pole is attracted, the attraction becoming stronger as the compass approaches the end of the iron mass. So marked is this that I have no doubt but, by the use of a very delicate needle, the exact center of gravity in any mass of iron may be accurately determined.

I once tested the heavy iron chains used to sustain the "drop" at the railroad ferry between Bath and Woolwich, on the Kennebec River, and found that each link has two distinct polarities—bottom north, top south—the needle whirling rapidly about as soon as the bearing point of the links is passed. This was at first a surprise, as it would seem that the great weight sustained by the chains would render them equivalent to a solid mass or bar of iron. Investigation showed, however, that the coating of rust on the chain served to insulate the links from each other. At least I could see no other reason, as in other connected pieces of iron, a large printing press, for example, the mass acted on the needle as a whole, as if it were one large piece, and not a combination of smaller pieces. In the large iron brace rods of a steamboat I found that where the ends were connected by a screw joint the action was the same as if the two were but a single piece; while where a swivel joint occurred, more or less insulated with paint and rust, the needle instantly reversed on passing the point of bearing.

The tops of all railroad rails I have tried attract the north pole of the needle, and the bottoms repel or attract the south pole. In car trucks whichever side is up is, for the time being, a south pole, changing constantly as the wheel revolves. This property is just as marked in all revolving iron wheels and pulleys, and upon trying the main shaft of the steamer Lewiston—a boat running between this port and Portland—it was found that although that piece of iron had been revolving day after day for nearly twenty-seven years, the same thing occurred. Whichever side of the shaft was up, for the time being, was the south pole, and whichever part was down was a north pole. This, it will be seen, shows that the direction in which the cables of the Brooklyn bridge run has no bearing upon the polarity of their upper and under sides, as the writer of the article I have referred to seems to think. Turn the cables over, and their magnetism would be instantly reversed.

Not to occupy your valuable space with a more detailed account of the many other interesting experiments made in this connection, I will only mention two of the exceptions noted:

First, having occasion to try a bar of iron that stood in my office entry in Wiscasset, when I there resided, I found to my surprise that reversing the bar did *not* reverse the polarity. This puzzled me at first (I had not then seen the paragraph in Silliman, previously referred to), but on investigation it proved that for about twenty-eight years—ever since the building was erected—the bar had stood in a nearly perpendicular position, the upper end inclining a little to the south. It was the support of a skylight, and had been removed from its original position in the course of some repairs made a few weeks before I accidentally tried it with my compass. To further determine the acquired magnetism of this bar, I suspended it by a small cord about its middle in the center of an adjoining room where it would be undisturbed, and found that its (for many years) lower end pointed due north as soon as it came to rest.

A few days ago I tried the magnetism of the "starting bar"—an iron bar some five feet long kept standing, when not in use, in a socket directly in front of the engine—in the engine room of the steamer Lewiston, and found that the polarity of that also had become fixed. The engineer informed me that the bar had occupied its present upright position for nearly twenty-seven years, having stood there ever since the boat was built.

Perhaps the facts mentioned in this article have been observed by others; if so, I would be glad to know when and by whom. My own experiments cover, as before stated, a period of some ten years, and should perhaps have been sooner made public. But the field of electric and magnetic investigation has been of late years so thoroughly cultivated that I supposed this apparently simple fact must be a familiar one to electricians. I should not venture even now to claim this as a "discovery," but for the fact that in an article occupying so prominent a place in the leading scientific paper of the world the writer mentions many things having an intimate connection with the great law referred to, yet fails to mention the law itself. Moreover, he attributes the facts he has noted to the peculiar situation of the iron masses experimented on ("causes which exist in New York city"), and not to a great general law which I claim governs *all* masses of iron and is not the result of "repeated blows or shocks." I also claim that the magnetism is *not* "permanent," save in rare instances, where the iron has remained in the same position for many years; neither is this property of iron peculiar to great cities—as may be demonstrated by any one possessed of a compass.

JOSEPH WOOD.

Bar Harbor, Me., Feb. 1, 1884.

DR. WEDL.

DR. KARL WEDL, Prof. of Histology in the University of Vienna, was elected Rector of the University for the term of 1883-1884 by the several faculties, in July, 1883. He was born in Vienna in 1815 and studied medicine at the Vienna University, from which institution he graduated in 1841. After traveling in France and England, and studying the medical colleges in these countries, he returned to his native country in 1845, when he published his earlier works. In 1849 he was appointed tutor of histology, in 1853 he was appointed professor, and in 1871 he finished his great work on histology, which is one of the masterpieces of medical literature.

The former Rector of the University of Vienna, Prof. Maassen, made himself very unpopular with the Vienna students, and, in order to avoid annoying demonstrations at the inauguration of Prof. Wedl, the affair was conducted with as little pomp as possible. Notwithstanding these precautions, very unpleasant and uproarious demonstrations took place in Prof. Maassen's lecture room. Prof. Wedl found it almost impossible to control the students, and on account of this was subjected to harsh criticism, which caused him to resign and return to his books. During the eventful time of his rectorship at the university he did not lose a single friend, but gained many.—*Neue Illustrirte Zeitung.*

DR. CARL WEDL, PROFESSOR OF HISTOLOGY IN THE UNIVERSITY OF VIENNA.

THE SCIENTIFIC BASIS OF COOKERY.*

By W. MATTIEU WILLIAMS, F.C.S.

ALTHOUGH by no means disposed to quibble about words, and having but small respect for etymologies, I am constrained to commence these lectures with an etymological protest. I refer to the now popular use of the term "technical education," which, in my opinion, is misapplied. If this was merely a question of derivations, I should not notice it, but, as now used, it is very inconvenient, and provokes confusion of ideas. It has prevented me from giving the proper title to these lectures, which should have been "The Technology of Cookery;" but, in the prevailing confusion between "technical" and "technological," such a title would not have been understood.

There are two distinct branches of all industrial education. The first is that which is conducted in the workshop, or, as regards cookery, in the kitchen. This is technical, and should be so named in accordance with the signification of the Greek word τέχνη, *i. e.*, art, trade, or profession, and also in accordance with the established usage of the English words technical, technicality, etc.

The other branch of industrial education is that which teaches the philosophy or *rationale* of the technical processes. Established usage and unquestionable convenience have assigned, in other cases, the appending of the Greek word λογος in English form to the Anglicized Greek name of the general subject, to express such special philosophy. Thus we have geology, the science of the earth; biology, the science of life; anthropology, the science of man, etc. In strict accordance with this, the science of trade, art, or profession, should be named technology, and its corresponding adjective technological, corresponding to geological, biological, anthropological, etc.

The distinction between the technical and the technological is specially and personally demanded for my present subject. I venture to present myself as a technological teacher of cookery, while I should be guilty of impertinent charlatanism if I came forward as a technical teacher of this important art. I am repeatedly compelled to make strong protests against the prevailing absence of intelligence respecting the distinction between the technical and the technological, on finding myself consulted on the technicalities of cookery, or challenged to display my skill by the concoction of a banquet or some of the elements thereof.

The technology of cookery is but a subdivision of general domestic technology, a very broad subject, about the broadest of all the technologies. In the majority of trades, only a limited range of material is handled, but the housewife has to deal with a multitude—the house itself, with its sanitary arrangements and furniture, its adaptation to comfort and elegance; food and its preparation; clothing; the rearing of infants, and the general preservation of health during health, and nursing during sickness; these demand for every woman a wider range of technological education than is necessary for men, who follow only one or two of the modern subdivisions of labor. The technology demand ed for the technical specialist is usually more exhaustive in detail, but is rarely, if ever, so wide in its grasp of many subjects. This should always be remembered in connection with the education of women. They certainly cannot afford to devote the larger half of their youthful working life to the study of dead languages or any other demands of scholastic pedantry.

The operations of cooking are mainly chemical, and the chief agent in effecting these is heat. Thus the cook is a practical chemist, and the kitchen is a chemical laboratory, whose practice demands for its regulation no small amount of chemical knowledge. I do not refer to the sort of chemical knowledge most valued by the chemical specialist, who is working in the hazy region which forms the outer boundaries of science, and lies between the known and the unknown, becoming, therefore, obscure and difficult; but to the solid foundations of chemical science, those great laws or general facts that are now so well established as to be clearly understood, and therefore easily explained. Divested

* Lectures recently delivered before the Society of Arts, London.

of shallow pedantries they are intelligible to everybody. The laws of heat stand first, that is, the actual facts concerning heat. These should be well understood by every cook and every housewife. They are extremely simple, provided they are not obscured by any envelopment in the mathematical complications of thermostatic and thermodynamic theories, which merely record the hard struggles of bold intellects in grappling with the unknown. These belong to the science of the university, not the simple, clearly understood, and easily taught technology of the kitchen.

In this short course I can only touch very briefly on this subject, just referring to the modes by which heat can be communicated, or the conditions on which this powerful agent will consent to become a servent to the cook. It must be either by means of *conduction*, *convection*, or *radiation*, either direct or reflected.

The first two demand contact with the heating agent, the third is the name for the manner in which heat is communicated to bodies at a distance from its source.

Conduction will be practically understood by simply holding a pin by one end, and placing the other end in the flame of a candle. The thumb and finger of the experimenter will presently communicate the fact that some of the heat of the candle flame has traveled from one end of the pin to the other. This unostentatious traveling of heat through the substance of body is called *conduction*.

By substituting for the pin a piece of charcoal or of wood of the same length (a match, for example), it will be found that one end of this may be made red hot without the other being sensibly warmed. A filament or stick of glass will display intermediate properties in this respect. We thus prove that bodies differ in their conducting power.

Metals generally are the best conductors, organic substances and carbon the worst among solids. The metals vary considerably among themselves. Silver and copper are the best of conductors; iron is inferior to these.

An important and less generally understood fact connected with this, is that bodies which thus take or conduct heat into themselves most readily are just those which give it out most readily, *by contact* with other bodies.

This is well illustrated by the boy's trick of placing a kettle of boiling water on the palm of the hand, and holding it there without inconvenience. The success of this depends upon the kettle being incrusted with a tolerably thick coating of carbon, in the form of soot deposit. The hand would be badly burned if the experiment were made with a new kettle, the heated metal of which would at once communicate its heat to the hand. In taking a Turkish bath, I frequently sit in a chamber the air of which is raised to the boiling point of water or thereabouts, and do this without inconvenience, provided the seat is covered with a bad conductor, and the floor also. If I attempted to wear my spectacles in that chamber, the result would be very painful.

Convection is very different from this, although it demands contact. The laws of convection of heat were first clearly expounded by the man that I profoundly respect as my great teacher of the technology of cookery, Benjamin Thompson, Count of Rumford, Knight of the Orders of the White Eagle and St. Stanislaus, Chamberlain and Privy Counsellor of State of His Most Serene Highness the Elector Palatine, Reigning Duke of Bavaria, and Commander-in-Chief of the general staff of his army, F.R.S., etc.

This remarkable man, who began life as a poor village schoolmaster in America, and afterward earned, by genuine honest work, the above titles, and many others that I have not time to specify, happened to scald his mouth when eating some rice porridge. The consequences were momentous, for it led him to investigate and discover the mode in which heat is communicated through liquids and gases, and to devise a multitude of important inventions based upon this. I quote his own account of the accident. He tells us that: "Being engaged in an experiment that I could not leave, in a room heated by an iron stove, my dinner, which consisted of a bowl of thick rice soup, was brought into the room, and as I happened to be too much engaged at the time to eat it, in order that it might not grow cold I ordered it to be set down on the top of the stove. About an hour afterward, as near as I can remember, beginning to grow hungry, and seeing my dinner standing on the stove, I went up to it, and took a spoonful of the soup, which I found almost cold, and quite thick. Going, by accident, deeper with the spoon the second time, the second spoonful burnt my mouth." This was followed up by reflecting on the fact that tea or coffee or thin soup is never thus cool on the surface and hot below. Why not?

Up to this time, it was supposed that when we boil water in a kettle, saucepan, etc., the whole becomes heated by contact with the metal, and by conduction through the water, similar to the conduction of the heat through the bottom of the pot from the outside to its inside. Count Rumford ultimately proved that water and most other liquids, that air, and all gases are very bad conductors of heat, absolute non-conductors, he supposed; and that when we make water hot in saucepans, boilers, etc., the heating is effected by continual movements of the liquid, a film of which, touching the bottom of the heated vessel, is heated by direct contact, expands, and thus becoming lighter ascends and gives place to another cold film, which does the same, and so on until the whole is heated; or, otherwise expressed, the heat is conveyed throughout by such motion, and hence the term convection. A device of Count Rumford's illustrates this very prettily. He placed in tall cylindrical jars of water small fragments of amber, having the same specific gravity as the water, and, therefore, neither predisposed to sink nor float. These, by their movements, displayed the movement of the water itself. When such a jar was placed before the window of a room, heated above the temperature of the outer air, the amber moved downward on the side of the jar facing the window, and ascended on the side presented to the interior of the room, and *vice versa*; if inner and outer temperature were equal, the amber remained stationary. He thus learned a domestic lesson, but little understood even now, viz., when to open and when to shut windows in summer time. His convection glasses proved that a house is often kept cooler by shutting doors and windows than by opening them.

It will be seen at once how largely we avail ourselves of convection in the application of heat in cookery. Boiling, stewing, and frying are examples of this, a bath of water or of fat being the convection medium by which the heat is communicated to the viands to be cooked.

All heated bodies radiate their heat to those around them, and all bodies are receiving radiant heat from their neighbors. If the temperature of a body is equal to that of its surroundings, it receives just as much heat as it gives out, and, therefore, is neither warmed nor cooled. If it is cooler than its surroundings, it receives more than it emits, and thus is warmed; if warmer, it radiates more than it absorbs, and thus is cooled proportionally. But the amount of heat thus radiated or absorbed by a body, in a given time, is not exactly proportionate to these differences. Some have greater radiating and absorbing powers than others. Thus, if we have two teapots of the same size and shape, and fill each with hot water from the same kettle, the water within them may or may not cool down at equal rates when similarly exposed. If one is of bright metal, especially burnished metal, and the other is of the same metal, but with a rough or porous surface, the rough will radiate more heat than the polished, and the water in it will cool more rapidly. In solid bodies the surface is the chief detriment of what I may term specific radiating energy. Radiation and absorption are, in this respect, exactly coequal; the conditions which favor one equally favor the other. One of the best radiators and absorbers is a surface of soot. Thus, a teapot should be bright in order to keep the water as hot as possible, but a tea-kettle that is heated by radiation from glowing coal should be thinly coated with smoke deposit, in order that it may absorb freely. The advantage of fire clay as the backing of a grate depends upon this. It is an excellent absorber and radiator, far better than iron or any other metal. Therefore, it is readily heated by the coal, it absorbs much of the heat that would otherwise pass by convection up the chimney, and, while doing this, is also actively radiating it into the room, or toward any object placed before it for the reception of such heat.

Bright surfaces are good reflectors of heat, although bad radiators. The difference of this should be clearly understood by the cook. Radiation is the giving off of the heat possessed by the radiant body at its own temperature. Reflection is the rejection of the heat radiated against the surface of the reflector, some of which it does not choose to accept, but scornfully throws back again to the giver if received perpendicularly, or casts aside at an angle equal and opposite to that of its reception if received obliquely.

A radiating body gives out its heat equally in all directions. A necessary consequence of this is that the intensity of the heat is diminished in proportion to the outspread, that outspreading being proportionate to the square of the distance. The *rationale* of this may be understood by supposing it to be received on the inside of a spherical shell surrounding the radiant body; as the area of that shell increases with the square of its radius or the distance from its center, the quantity of heat received on a given measure of the surface of the shell must be inversely as the distance from the center, *i. e.*, at double the distance the surface of the sphere will be four times greater, and o utspread heat four times, or diluted to ¼, at three times ⅓, and so on.

In roasting a joint before the fire without any screen, the radiant heat from the coal is only used; the meat is heated only on one side, that next to the fire, and, as it turns around, is radiating its heat away from the other side to the wall, etc., of the kitchen. If a meat screen of polished metal is placed behind the meat, the rays of heat not intercepted by the meat itself are received upon the screen, and reflected back toward the meat, and thus both sides are heated.

The Dutch oven is a device for utilizing the otherwise wasted radiant heat, by reflecting some of it to the part of the meat not opposite to the fire. Other devices for this purpose are familiar to all, and, if time permitted, I could show you how a reflector might be made to concentrate the heat in such wise that one part of the meat turned away from the fire should be more heated than that exposed directly to the fire. I merely give these examples to show that a study of the laws of heat have a direct bearing on practical cookery.

The oven is an apparatus for cooking by radiation. In this case the meat or other object o f cookery receives radiant heat from the heated walls of the oven. If this chamber, with radiant walls, be so arranged that the heat shall be radiated equally on all sides, and is capable of regulation, it becomes a roaster, which theoretically does its work more perfectly than an open fire, even when aided by a screen.

Rumford proved this by constructing such a roaster. It was a cylindrical chamber, with a surrounding flue, which heated the chamber about equally all around, excepting at the bottom, which stood directly over the fire, and therefore was the hottest. Over this stood a dish containing water, and above the water a sort of gridiron, upon which stood the meat, over a dripping pan above this water pan. It was thus heated by nearly equal radiations from all sides up to the ordinary cooking point (of which I shall presently speak), and in the midst of *its own* vapors plus some steam from the water in the dish. When this heat had penetrated to the center of the meat, so as to effect the chemical changes presently to be described, and which constitute ordinary cookery, the special peculiarity of roasting, that is, the browning of the surface, was effected by means of what he called "blowpipes," *i. e.*, metal tubes under the roaster, which were made red hot by direct exposure to the fire, and were so arranged that, by opening suitable plugs and valves, a blast or current of hot air was made to pass through the roaster, and thus the meat was browned on the outside, while it remained delicately tender inside, from having been previously cooked there in its own juice, and surrounded by its own steam.

To test its merits practically, he took two legs of mutton of equal weight, and from the same carcass, had one of them roasted by an expert cook in the usual manner before the fire, and the other cooked in the roaster. When cooked, both were weighed. That cooked in the roaster was 6 per cent. heavier than the one cooked before the fire. They were both brought on table at the same time, "and a large and unprejudiced company was assembled to eat them," a poor and hungry company, if I understand rightly. Both were found good, but a decided preference was given to that cooked in the closed roaster. "It was more juicy, and was thought better tasted." Both were fairly eaten up, nothing remaining of either that was eatable, and the fragments collected. "Of the leg of mutton which had been roasted in the roaster, hardly anything visible remained, excepting the bare bone, while a considerable heap was found of the scraps not eatable which remained of that roasted on a spit." The silent eloquence of these scraps is to my mind irresistible.

But why has the Rumford roaster so completely disappeared that I am unable to obtain a specimen from the exhibition of cooking utensils that we have below?

There are two reasons. First, that one of the primary conditions of Rumford's experiment with the two legs of mutton are generally unobtainable in England, viz., the "perfectly unprejudiced company," to test its merits. A prejudice against baked meat, or meat roasted in an oven, is hereditary in Englishmen. Not one in a hundred who denounce it has ever consciously tried the experiment of comparing such meat with that roasted in an oven, although every one of the hundred has again and again eaten and enjoyed baked meat, believing it to be roasted. If he has not done so at home, he has at hotel dfuners and other costly banquets.

I have fairly compared both, and have not the slightest hesitation in affirming that moderate-sized joints, properly roasted in a close chamber, are far better than similar joints cooked with the utmost skill in front of a fire. The smaller the joint, the greater the advantage of the closed chamber. A baron of beef or a whole ox may possibly be as well cooked on a spit before a large fire as in an oven. I have tasted such from the spit, but never from an oven, and therefore suspend judgment in this exceptional case. All prejudices, all traditions, however unreasonable now, have had some reasonable or semi-reasonable origin. Whence came this one against baked meat? Though far from being an archæologist, I claim to have discovered the origin of this tradition, this domestic superstition. My theory is this: Once upon a time, and within the memory of living men, the great middle class of Englishmen, such as now reside in suburban villas, and scorn to associate with the local shopkeepers, lived in London; in the back parlor, behind their own shops, on week days, and in the first-floor drawing room over the shop on Sundays. These now aristocratic and fastidious people kept but one servant in those days, and she of the type of Dick Swiveller's beloved Marchioness. At certain times, the mistress could not herself superintend the cooking of the dinner. The joint was then placed on a triangular support, in an earthenware dish, with potatoes below, and sent to the nearest baker, to be cooked in his oven, for a fee of one penny, or thereabouts. In this oven was closely packed a variety of viands sent there by a variety of people—pork or goose stuffed with sage and onions, side by side with beef and mutton; high and gamy bare next to delicate lamb or chicken. The whole of the hermetically sealed chamber was thus filled with heterogeneous vapors and flavors, with a fair probability of one or two joints being of objectionable quality. But this was not all. An ordinary baker's oven is constructed for baking bread. The walls are heated to a maximum temperature, the fuel then removed, and the bread placed in it to "soak," as it is termed. The oven gradually cools down, and its contents are cooked at a gradually diminishing temperature. This is just the opposite of the action of Rumford's roaster, and certainly adapted to produce very unsatisfactory results when meat takes the place of bread.

The second cause of the disuse of Rumford's roaster is, that it is not adapted to our fireplaces. He fitted it over a specially constructed fireplace, which offered the cook no opportunity of indulging in her favorite pastime of wasting coal. With our ordinary fireplaces or kitchen furnaces, the blowpipes of the Rumford roaster would be oxidized and burnt through in a week or two.

Roasting-ovens, however, do exist, and are attached to all the best forms of kitcheners; and I find at home, and in other domestic kitchens that I have visited, the double waterpan, the dripping-pan, and meat stand of precisely the same model as contrived and pictured by Rumford as essential to his roaster.

On one point, however, in the philosophy of roasting, I differ from my teacher. He begins at a low temperature, or the mean temperature. I think it desirable—and have tested this theory experimentally—to begin at a temperature above that which is to be maintained throughout the roasting. The object of this is to produce a crust on the surface of the meat that shall partially seal it, and keep in the juices as much as possible. Then the temperature may fall to the average, which should be well kept up, and rather raised toward the last. This comes about automatically in the ordinary course of cooking with a roasting-oven. When empty and closed, it is receiving heat, and only radiating to its own opposite sides, from which the same amount of heat is mutually received. When the cold joint goes in, these radiations are obstructed, and each side is giving to the joint far more than it receives from it; therefore, according to the simple law already stated, the sides must fall in temperature. As the meat becomes cooked, it takes less from the oven walls, and thus they become hotter.

I may add that the sealing is more demanded by a joint of beef than by one of mutton of given size, because in the beef there is more of cut surface, exposing the ends of the fibers of the meat. In a leg of mutton, for example, this exposure is only at one end, the rest partially protected by the skin of the leg.

The *rationale* of basting appears to be that it assists in the sealing, and diminishes the evaporation of the juices of the meat, the chief difference between well-roasted and ill-roasted meat depending upon this. I have defined the roasting and grilling of meat as processes of cookery by means of which the meat is stewed in its own juices. The flavor depends on this: no water being used, these juices are not diluted—they are, on the contrary, more or less contracted by evaporation; but if this evaporation be carried too far, a drying-up occurs, and this desiccation, for reasons that will be explained presently, is accompanied with toughness and indigestibility, as well as sacrifice of flavor.

The smaller the joint, the greater the risk of such desiccation. This principle brings us at once to grilling, which is another kind of roasting. *i. e.*, of cooking by radiation. A beef steak or mutton chop is not roasted by turning it round and round in front of the fire, because so large a surface is exposed in proportion to the mass, and such treatment would evaporate from that large surface too much of the juices. Rapidity is the primary condition of success in grilling. When a large and specially-constructed grill, placed over a large coke or charcoal fire, is available, the heat radiated on the exposed surface of the meat rapidly browns or carbonizes the exposed surface, and partially seals its pores.

If flesh were as good a conductor of heat as silver or copper, two or three minutes would be sufficient for a chop or steak, and ten or fifteen for a sirloin of beef; but as the heat has to pass through very slowly, the time is proportionately extended. If we attempt to grill a baron of beef or a whole ox, it would be actually burned to a cinder on the outside before the center became warmed. Hence the necessity of the continuous basting of these great masses of meat.

Chops and steaks are commonly spoiled in domestic cookery from want of understanding these principles, and from mistaken notions concerning different kinds of flames. Every cook knows that if the flame of a coal fire comes in contact with a steak, a villanious flavor of tar is the result. This arises from an actual deposition of tarry soot on the meat. Hence she scrupulously avoids contact with any kind of flame. This is quite unnecessary; the flame caused by combustion of the fat of the meat itself makes no such tarry deposit, however much it may blacken the meat. I said that I am not a practical cook, but I make exception in the matter of grilling. When a bachelor, living in lodgings, or an institute, I found such difficulty in obtaining a decently cooked steak or chop, that I frequently cooked my own,

and my mode of proceeding may be described, as it illustrates these principles.

First I removed all the flaming coal, even though in so doing the fire was reduced to very poor dimensions. Then I cut off a piece of the fat, cast this in the middle of the fire, and as soon as it made a good flame recklessly plunged my dinner into the midst of it. It spluttered and frizzled, dropped more fat, made a bigger flame, but still I refused to raise the gridiron, and thus cooked it throughout in its own flame. A few minutes sufficed. The outside edges were black, certainly, but the violent expansion of the juices within, when so suddenly heated, plumped up the lean almost to bursting; the inside was juicy red meat, fully cooked, though apparently raw, and the outside a crust that was by no means objectionable, though it might arouse the prejudice of the uninitiated. I do not recommend the exact following of this in detail where a good fire is available, but refer to it as illustrating the effect of rapid grilling.

Before going into the subject of boiling and stewing, I must say something about the boiling of water, as this is curiously misunderstood in most kitchens. When water is heated in a glass vessel over a flame where the action may be watched, bubbles are first seen growing on the sides of the glass, gradually detaching themselves, and rising to the surface. These are merely bubbles of air that was dissolved in the water. After this, other and larger bubbles form on the bottom just above the flame. At first they are flat, and continually collapsing. Presently they become hemispherical, but still they collapse; then they become more and more nearly spherical; and afterward quite spherical; afterward they detach themselves, and start upward, but perish in the attempt, by collapsing somewhere on the way. At last they reach the surface, and break there, ejecting themselves as steam into the air. Now the water boils, and a thermometer dipped into it registers 212°. After this, it matters not whether the boiling is very violent or only the gentlest simmering; no further rise of the thermometer is perceptible, showing that the simmering temperature and the "galloping" temperature are the same.

It is most difficult to make a cook understand this. If something is to be kept below the boiling point, she puts the saucepan where the water will only simmer, firmly believing that thereby she is maintaining a temperature considerably below the boiling point, and, on the other hand, she believes that by making the water boil violently she is raising its temperature above the ordinary boiling point. This single, and almost universal, kitchen fallacy, prevailing as widely among the mistresses as the cooks, wastes a serious amount of fuel, and spoils tons and tons of good food every day, proving most strikingly the demand for a knowledge of the laws of heat by all concerned in cookery.

The temperature of water cannot be raised above a fixed boiling point, because every ounce of steam carries off nearly 1,000° of heat, *i. e.*, it requires so much to expand it as steam. Time will not permit me to go further into this subject of latent heat; all housewives and cooks should carefully study it.

The actual cooking temperature for animal food is considerably below the boiling point of water, and is regulated by the coagulation of albumen, which commences at rather below 160°, *i. e.*, more than 50° below the boiling point of water. The further elucidation of this belongs to the subject of my next lecture, but I may illustrate it in the mean time by what occurs in the cooking of the white of an egg, which is nearly pure albumen.

If this be gradually heated in a suitable glass vessel, with an immersed thermometer, the clear viscous liquid shows signs of change at about 134°, when white fibers commence forming within it. These go on increasing, until at about 160° the whole mass becomes gelid and semi-opaque. It is now delicately cooked, and best fitted for easy digestion without any of the disagreeable rawness of the uncooked slimy liquid. If the heat is continued up to 212°, the opacity and hardness increase; if this temperature is maintained, the albumen becomes of horny hardness; if exceeded, it becomes so tough that a powerful cement may be made, and is made by smearing the edges to be cemented with white of egg, and then heating them. Thus hardened it is unfit for food.

Now, apply this practically to the boiling of an egg for breakfast. By the ordinary method of the three minutes' immersion in continually boiling water, the white becomes hard and indigestible before the yolk is fairly warmed, and half a minute too much, or half a minute too little, will nearly ruin the operation. Cockney cooks know very little concerning new laid eggs, but farmhouse cooks are well aware that a new laid egg demands nearly a minute more of that sort of cookery than one of full London flavor.

The proper mode, as I pointed out years ago, in my first book on Norway, is to place the egg in boiling water, and then remove the saucepan from the fire altogether, and leave the egg in the water from ten minutes to a quarter of an hour. About half a pint for one egg, three-quarters of a pint for two eggs, or a pint for four eggs, is the quantity demanded if the saucepan is well covered.

The cold egg or eggs speedily reduce the temperature from 212° to near the cooking temperature, and before the egg is warmed throughout it is quite down to 160°, so that it matters little whether it now remains five or ten minutes longer in the water. In making experiments with eggs, I have discovered that the temperature of congulation of the yolk is lower than that of the white, and thus, if the egg is kept in water at 160° for a long time, the yolk may become harder than the white, the center having time to become nearly as warm as the outside. But for this, the egg might be kept in the water at about 160° for an hour or two.

I have here exhibited, by Mr. Burton, an apparatus specially constructed for the cooking of eggs. It is called an "egg coddler." Being made of bright metal, and well covered, the heat of the water is retained, and a smaller quantity than I have named is sufficient. The eggs are supported in a movable frame, which can be taken out, carrying the eggs with it; nothing more is necessary than to place these on the breakfast table duly charged with eggs, fill it with boiling water about ten minutes before the attack on the breakfast is anticipated, and if this should be delayed ten minutes later, no serious mischief is done; the eggs are not hard, and are still hot. Coddle your eggs, never boil them.

In my next I shall show the bearing of these principles of albumen coagulation upon the cooking of all kinds of animal food.

IT is announced that Mount Etna is again in a state of eruption, accompanied by strong earthquake shocks. An eruption occurred last year at about the same time, which lasted about one month. In view of the serious consequences of the action of Krakatoa in Java, great interest is attached to the present outbreak.

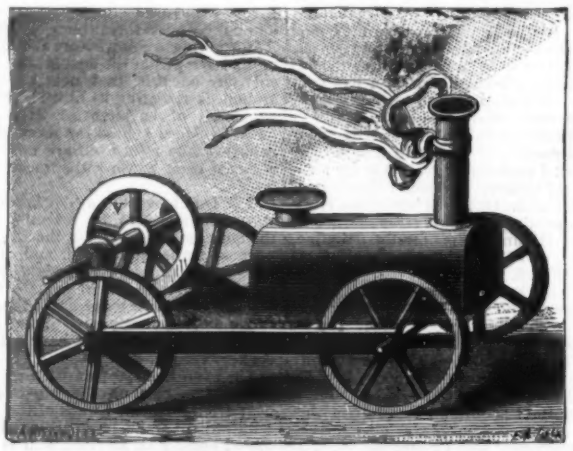
AN ILLUSTRATION OF INERTIA.

As it seems to us that it will prove of interest to treat of the mechanics of toys every time that an occasion shall offer itself, we desire now to call the attention of our readers to a very simple and ingenious machine, which is called in commerce the "roadway locomotive," and which well shows the principles of inertia and live power.

We know that in order to communicate a certain velocity to a given mass it is necessary to expend a certain quantity of *energy* under the form of mechanical work, and an energy, too, that is proportional to the mass of the body and to the square of the velocity communicated to it. We likewise know that bodies having such velocity return to a state of rest only after having expended, under some form or other, such *live power*, either through friction or in effecting other mechanical work, etc.

It is by virtue of live power that billiard balls roll, that the cannon ball makes its way, and that tops and gyroscopes revolve. The motion of these latter has so great a duration only because friction is reduced to a minimum, and because they revolve at a great speed, and consequently possess much live power, which becomes less only very slowly.

This live power we may utilize for setting a wheel in motion by any system whatever, and finally for effecting progression, as in the little apparatus here shown. The toy consists of a flywheel, V, which is set rapidly revolving by means of a string wound around its axle and afterward forcibly unwound, as in the operation of spinning a top. The axle of this wheel rests upon the hind wheels of the vehicle, and the rim of each of these is covered with rubber, in order to increase the adhesion between it and the said axle. As the latter is about one millimeter in diameter and the driving wheels about fifty millimeters, it results that during one revolution of the flywheel the driving wheels undergo one-fiftieth of a revolution; but, as the initial velocity of the flywheel is very great, it results that they are carried along quite rapidly, and when the machine is placed upon the floor its forward motion occurs with a velocity that regularly decreases in measure as the revolution, and consequently the live power of the flywheel, diminishes. Upon a very even surface it is nevertheless possible to make the machine run from 20 to 30 meters before stopping. It is useless to say that the boiler and smokestack are added merely as a matter of form.



AN ILLUSTRATION OF INERTIA.

This little toy, which costs but little, may, then, be utilized for showing the principal laws of mechanics and for proving once again the principle of the conservation of energy.—*La Nature.*

THE GROWTH OF LONDON.

ON Jan. 8 last Sir J. W. Bazalgette, C.B., delivered his inaugural address as President of the Institution of Civil Engineers. The subject selected was the growth of London, than which nothing could be more appropriate, considering the position of the author as the engineer to the Metropolitan Board of Works. After a reference to the increase in the number of members of the Institution, Sir J. W. Bazalgette said:

POPULATION AND TRAFFIC.

London, or the metropolis as defined by the Metropolis Management Act of 1855, contains at the present time nearly 4,000,000 of people, covering an area of 117 miles, upon which are built 500,000 houses, giving an average of eight persons to each house, and nearly seven houses and fifty-three persons to each acre. Its population is equal to that of the whole state of Holland, is greater than that of Scotland, and double that of Denmark, and if it continues to increase at the present rate until the end of the century, it will then equal that of Ireland, as, indeed, Outer London now does. The value of property in London has increased even more rapidly than its population. In 1841 its ratable value was 6,000,000*l.* sterling, in 1855 it was 10,500,000*l.*, and at the present time it is 28,000,000*l.*, having increased nearly five-fold in the last forty-three years. But the traffic through London has increased even more rapidly than either its population or ratable value. The arterial lines of thoroughfare, which were wide enough half a century ago, are now altogether insufficient. Thus, for instance, although the Strand and Cheapside have been relieved by the formation of a new route between Charing Cross and the Bank, along the Victoria Embankment and Queen Victoria Street; and Holborn has been relieved by a new route from Oxford Street to Shoreditch; and new and widened streets continue to be made through the City and other crowded localities; the old lines of throughfare still remain congested by the traffic; 384,000 pedestrians and 75,000 vehicles now pass over the metropolitan bridges daily; and the number of pedestrians increases at the rate of 4¼ per cent. per annum, while the vehicles have increased at the rate of 13 per cent. The traffic on three metropolitan railways, viz., the Metropolitan, the Metropolitan District, and the North London, together increased between 1871 and 1881 from 79,000,000 to 186,000,000 per annum, or to 373,000 passengers per diem.

GOVERNMENT.

The government of the ancient City of London, by its Lord Mayor and Corporation, has up to the present time remained intact, with all its privileges and wealth; excepting that as part of the general municipality it sends three members to the Metropolitan Board of Works. But the metropolis has from time to time been placed under the management of various local authorities. Prior to 1848 there were seven independent commissions of sewers. These were then consolidated into one commission. In 1855 the principle of local self-government was adopted, and thirty-eight vestries or district boards, under the control of the Metropolitan Board of Works, were substituted, being representative bodies. The Metropolitan Board was also clothed with additional powers and duties; and these have almost every subsequent year been enlarged, until it has now become the administrative authority for over 100 Acts of Parliament, affecting the metropolis. The present government, however, have contemplated the creation of a new municipality, which shall include the City and govern all the interests of the metropolis as a whole.

STREETS.

In 1878 there were 1,710 miles of streets, roads, and courts, 1,338 miles of which were macadamized or flint roads of an average width of 30 feet between the channeling, and upon which was laid in the course of the year 307,700 tons of macadam, flint, or hoggin; 274 miles were granite paved roads, 61 miles were paved courts, 15 miles wood paving, and 22 miles asphalt; but since that period wood paving has been extensively substituted for some of the other kinds.

DRAINAGE.

There are now about 2,300 miles of underground covered sewers, more than half of which have been constructed during the last twenty-seven years. They vary in size from 9 inches to 12 feet 6 inches in diameter. All the houses are connected with them, and the house refuse and the most offensive decomposing matter is removed through them by the water supplied to the houses flowing through the sewers after use, in an unobtrusive, inoffensive, and economical manner, and without manipulation of any kind. The waste water thus becomes the motive power or carrier for conveying the refuse to covered reservoirs on the banks of the Thames twelve miles below London Bridge. These reservoirs are 16 acres in extent, and capable of containing 60,000,000 gallons; and an average of about 150,000 gallons of sewage and rainfall are discharged at the outfalls into the river daily on the ebb tides. The main intercepting scheme was practically completed and came into operation in 1870–1871; and, considering that the mean annual death-rate in London was in the decade ending 1850 24·8 per 1,000 in that ending 1860 23·7, in that ending 1870 24·4, and in that ending 1880 it had been reduced to 22·5 and for the year ending 1882 was only 21·4, it may not be unfair to claim for those works a considerable share in this decrease of the deaths. But a decrease from 24·4 to 21·4, or three persons per 1,000, represents about 12,000 lives saved every year in London, and a proportionate increased length of live to the living. The death-rate for the past year has not yet been published, but it will probably befound to be about 1 per 1,000 lower than in 1882, so that the improvement since 1870 has been continuous, and the annual saving of life now as compared with 1870 is about 16,000.

WATER SUPPLY.

London is at present supplied with water by eight independent water companies. They supply in the aggregate 140,000,000 gallons daily, of which from 15,000,000 to 18,000,000 are consumed outside the metropolitan boundaries. The consumption within the metropolis is at the rate of about 31 gallons per head per diem. Of the total quantity, 69,000,000 gallons are obtained from the Thames, and 71,000,000 from the River Lee, the New River, and other sources. The charges of the water companies for the water are, with minor exceptions, based upon the ratable value of the houses supplied, and not according to the quantity of water consumed; that is to say, by their Acts of 1852, the Chelsea, the Grand Junction, the New River, and the West Middlesex Water Companies are authorized to charge 4 per cent. on houses rated under 200*l.* and 3 per cent. on houses rated over 200*l.*; and the East London and the Southwark and Vauxhall to charge 5 per cent. on the ratable value of all houses; while the Lambeth, by their Act of 1848, may charge water rates varying from 7½ per cent. on small houses to 5½ per cent. on houses rated over 100*l.*; and the Kent company, by their Act of 1864, may charge from 6 per cent. in small houses to 4 per cent. on houses rated at 90*l.* and upward; and all the companies are authorized to make additional charges, fixed according to ratable value, for baths and waterclosets, and in some cases for high service. But inasmuch as the ratable value of the houses in London has risen since 1855 from 4*l.* per head to 7*l.* per head of the population, and the consumption of water per head has remained the same, the price of water, as based upon the ratable value, is now 75 per cent. dearer than it was in 1855; and there is no reason to doubt that so long as the price remains a fixed charge upon the ratable value of the

houses, the cost of each gallon of water consumed and the value of the property of the water companies will continue to increase in every future year in the like ratio. The total capital employed by the water companies is about 13,200,000 *l.*, or at the rate of 61·7 *d.*, per 1,000 gallons of water supplied, and the net charge for water amounts to 7·3 *d.* per 1,000 gallons; while the annual cost of pumping and maintenance of works is 1·1 *d.*, and the cost of engineering and management is 2·1 *d.* per 1,000 gallons, showing a net profit of 4·1 *d.* per 1,000 gallons. In 1880 it was proposed to purchase the interests and property of the water companies, and place the water supply under the municipal authority, as it is in Glasgow, Manchester, Liverpool, and in most foreign cities; and an arbitrator between the Government and the water companies valued their interest at that time at 33,000,000 *l.* The mode of charging upon the ratable value of the houses, instead of by meter, moreover, makes the payment for the quantity consumed fall very unequally upon the consumers. If charged by meter, a very effective check would be put upon the serious waste which now takes place. A purer and more copious supply of water on constant supply and at high pressure is demanded, and whether this is to be attained by purchase or by some regulation of the present water companies' powers, it is obvious that each year's delay will only increase the cost and the difficulties involved.

GAS AND ELECTRIC LIGHTING.

The lighting of the metropolis is effected mainly by three gas companies, at a cost varying from 2*s.* 10*d.* to 3*s.* 2*d.* per 1,000 cubic feet. Over 20,000 millions of cubic feet of gas per annum are manufactured out of two millions of tons of coal, and it is distributed through pipes, the total length of which is about 2,500 miles, and they vary from 3 inches to 4 feet in diameter. The cost of lighting London by gas is therefore about 3,000,000 *l.* per annum, or more than double the cost of its water supply. But electric lighting is rapidly advancing; and, in confirmation of Dr. Hopkinson's opinion that it may be looked upon as the lighting of the future, it may be mentioned, that when, in 1878, the Jablochkoff Company commenced lighting a portion of the Victoria Embankment, the charge for each lamp was 5 *d.* per hour. At the end of the three months the price was reduced to 3 *d.* Six months later it was reduced to 2½ *d.*, and since June 1881, forty lights on the Embankments and ten on Waterloo Bridge have continued to be lighted at the rate of 1⅛ *d.* per light per hour. Each of the electric lamps on the Embankment gives an illuminating power of 265 candles, so that, at the charge of 1½ *d.* per hour per lamp, the cost per 1,000 candle power is 5·66 *d.* per hour; while gas, at 3 *s.* per 1,000 cubic feet, and consuming five cubic feet per hour for every sixteen candles, costs per 1,000-candle power 11·25 *d.* per hour. In other words, twice the illuminating power is at present obtained on the Embankment by electric lighting for the same money if expended on gas. But it has been stated that the Jablochkoff Company are losing money on this contract. Incandescent lighting, though much more costly in production, is more economical in the regulation and distribution of the light.

BRIDGES, ETC.

Eleven of the bridges over the Thames, on which tolls were levied, have been purchased, and made free of toll within the last five years. At Hammersmith, Putney, and Deptford Creek new bridges are in process of construction. A new bridge at Battersea will shortly be built, and others have been strengthened with new chains or deeper foundations. But, considering that over 1,500,000 people live east of London Bridge, that is to say, a greater population than exists in any city in the world, except London and Paris, it cannot be doubted that there is still a great need of improved communication across the river below London Bridge. The Victoria, the Albert, and the Chelsea Embankments of the Thames are a total length of about 3 miles, and by them 52½ acres of mud foreshore have been reclaimed from the river and converted into thoroughfares and ornamental gardens.

PROTECTION AGAINST FIRE.

Since 1865 the extinction of fires and the saving of life and property from fire has been a duty cast upon the municipality, and a brigade is maintained, under the direction of Captain Shaw, containing 54 land-engine stations, 4 floating engines, 124 fire-escape stations, 576 firemen, 41 steam and 115 manual fire engines, besides tugs and other appliances. There were, in 1882, 1,926 fires, of which only 164 resulted in serious damage, and only 36 persons lost their lives, owing to the able management and gallant conduct of that small staff. The consumption of water in extinguishing fires is about 17,000,000 gallons, and the cost of the brigade is rather over 100,000 *l.* a year.

POLICE, ETC.

The metropolitan police outside the City are under the supervision of Commissioners appointed by the Government; but the Corporation of the City appoints its own police. They number in all 13,000; the area protected by them extends over Outer London, and covers 700 square miles, and the proportion of police to the population is rather less than in Paris, which is one in 373. But the area over which the metropolitan police are scattered is twenty-three times larger than Paris, and it is satisfactory to know that, in spite of the amount of crime which escapes detection and punishment, London is the safest capital for life and property in the world. There are in London about 10,000 cabs and 2,000 omnibuses or stage-coaches, under the management of the metropolitan police.

PARKS.

The parks, commons, and open spaces which are available for public recreation within the metropolis, and which form the lungs of London, are 42 in number, and contain about 4,490 acres, exclusive of the squares, or about 6 per cent. of the whole area of London; while just outside the boundary are Epping Forest, Richmond Park, and Wimbledon Common, together containing over 9,000 acres more.

MARKETS.

There are 14 markets of various kinds. The most important of these are: Farringdon dead meat and poultry market, and Deptford foreign cattle market; Islington cattle markets, 15 acres in extent; Billingsgate fish market and Covent Garden vegetable market; and into these markets are imported annually, for consumption in London, about 800,000 head of cattle, 4,000,000 of sheep, claves, and pigs, also 9,000,000 of fowls, game, and rabbits, and over 100,000,000 of eggs, and a like number of oranges and lemons. About 320,000,000 of quartern loaves are consumed in London annually. Billingsgate fish market covers only half an acre, and, being insufficient for the supply of fish to the whole of London, a new market is contemplated. Thirty-five thousand vessels and 100,000 fishermen are employed in catching fish upon the coasts of the United Kingdom, and, besides the fish exported, 400,000 tons of fish are consumed in this country, of which 130,000 tons are sent to London, two-thirds by rail and one-third by water. The average wholesale price of fish sold in Billingsgate is 1¼ *d.* per lb., but the consumer does not get the benefit of this low rate; and to enable the poorer classes to enjoy the food which so abundantly surrounds our shores, a market is needed which shall be accessible to all railways, having the means of storing fish in dry air at a temperature of 34 degrees, and accompanied by the means of rapid distribution to all parts of the metropolis.

COMPARISON WITH PARIS.

Paris contains a population of 2,240,000, occupying 77,000 houses, and covering an area of 30 square miles. This gives an average of 29 persons per house, and 4 houses and 116 persons per acre. Paris, therefore, is more than twice as densely peopled as London, and each house in Paris contains nearly four times as many inmates as the London houses. Its ratable value is 24,000,000 *l.* sterling, being not quite one-third less than that of London. It has 582 miles of streets, upon which are laid 73½ miles of tramways, and the total length of its sewers is 440 miles. Great care and labor are expended in cleansing and watering the streets and ornamental spaces in Paris. From a surface of over 13,000,000 square yards of street are removed annually 100,000 cubic yards of deposit, equal to a depth of ¼ inch of mud, dust, and garbage spread over the whole surface. The cost of street cleansing in 1881 was 245,000 *l.*, with a further expenditure of 82,000 *l.* for removing snow. The annual rainfall is 22 inches. The water supply amounts to 82,000,000 gallons per diem, being at the rate of 36 gallons per head of the population. Two-thirds of this are obtained from the rivers Seine, Marne, and Ourcq, and one-third from distant springs and artesian wells in Paris. Its sewers vary in size from 6 feet 6 inches by 3 feet to 18 feet 5 inches by 14 feet 5 inches; but the larger ones are, in fact, subways, containing galleries with a channel in the center, and water pipes overhead. The construction of these has cost over 4,000,000 *l.*, and their cleansing and maintenance about 50,000 *l.* a year. A small portion of the sewage is disposed of by the irrigation of garden ground in the neigborhood of Paris, but by far the greater portion is still removed out of the city in cans by carts. In 1869, 600,000 cubic yards were thus removed, at an annual cost of about 2 *s.* 3½ *d.* per head of the population. There are four abattoirs under the administration of the municipality. Paris is lighted by gas lamps equivalent to 44,000 lamps of one burner each, which consume 770,000,000 cubic feet of gas, at a cost for gas of 130,000 *l.*, or about 3 *s.* 4 *d.* per 1,000 cubic feet, and a total cost of 190,000 *l.* per annum, including lighting and maintenance. This latter sum includes also the electric lighting of the Avenue de l'Opera, the Cours de Louvre, and the Carousel; but this does not include the cost of lighting the private houses. There are in Paris 600 omnibuses, 520 tramcars, 500 steamboats on the Seine, over 8,000 cabs, and the city is protected by a force of 6,000 men, acting as police.

THE UNIVERSE OF SUNS.

By R. A. PROCTOR.

IT is admitted that Lambert's theory, though published five years later than Kant's (or in 1760),* was formed quite

LAMBERT'S THEORY OF OUR STELLAR SYSTEM.

independently; but Kant himself remarked in 1763 that "the accordance between his ideas and those of Lambert (*cet homme spirituel*) extends even to the most minute details." It will be found, I conceive, that no such close agreement exists between the two theories.

Lambert's theory consists of the following theses:

1. The stars are suns, and like our sun they are the centers of planetary systems. Each sun with its dependent worlds forms a *system of the first order*. (It will be observed that this agrees with Kant's first thesis—which, however, was earlier enunciated by Huyghens.)

2. Our sun belongs to a vast gobular cluster of stars, *a system of the second order*, which includes all those stars, spread over all parts of the heavens, which do not belong to the Milky Way.

3. There are many systems of the second order. They are not spread throughout all space, but are all found near a certain principal plane or mean level, and being ranged one behind the other to a great depth, they form by their concourse the Milky Way. This is *a system of the third order*, not globular, but flat—forming, in fact, a disk, whose diameter vastly exceeds its thickness. The fact that this system of the third order consists of different systems of the second order is shown, says Lambert, by the irregularity of the Milky Way, by the different richness of its various parts, and by its branching figure. (It will be noticed that Lambert here adopts a view resembling a part of Wright's theory on which Kant says nothing; but Lambert's views are much more definite than Wright's, and accord much better with the results of Sir W. Herschel's later labors.)

4. Analogy suggests that there are in the universe many Milky Ways. Perhaps the nebula in Orion is a Milky Way, nearer to us than the rest. Should this be the case, telescopic research will reveal many others, forming together *a system of the fourth order*.

5. Analogy suggests that there are *systems of a fifth order*, and of yet higher orders. But so far as observation is concerned, stellar astronomy includes—1, suns; 2, clusters of suns; 3, the Milky Way; and 4, systems of Milky Ways.

6. The common bond of different systems of the same order, as well as of the successive orders of systems, is gravitation, which produces concentric motions within all the systems.

7. As in the solar system we observe that the distances between the several planets exceed incomparably the dimensions of each planet or scheme of planet and satellites, so the distances between sun and sun exceed enormously the dimensions of the several solar systems.*

8. A similar relation prevails among higher orders. The cluster to which the sun belongs contains above a million and a half of stars, forming a spherical cluster, whose diameter exceeds 150 times the distance of Sirius; but this diameter is far less than the distance of the nearest cluster of suns.

Other theses which follow need not here be considered, because they relate to matters already discussed, and are for the most part based on imperfect evidence, and also (as the elder Struve has shown) on incorrect ideas. But Lambert's conceptions respecting central suns are worthy of notice. They are included in the following theses:

9. It seems clear from the analogy of the solar system, that each of the clusters of suns must be ruled by a central orb. No otherwise, it would appear, can the motions within the cluster have the requisite stability.

10. The mass of such a central sun must be very great. Its luminosity may be faint, or it may even be an opaque body, illuminated by the suns which travel nearest to it. If suns are intended to illuminate dark orbs, we may infer that the central orb is thus illuminated. So that whereas in solar systems the central body illuminates the rest, in systems of suns the central orb receives light from the bodies over which it bears sway.

11. The central orb may one day be detected by the perturbations which it produces within our solar system—much as the sun produces perturbations in the lunar motions. Or it may have phases, or dark spots, and so be detected by its rotation. On this account the nebula in Orion, which may be the central orb of our cluster of suns (since it lies in the proper direction) should be carefully watched.

12. Having accepted the belief that a central body sways each cluster of suns, we may infer from analogy that a central orb of yet vaster dimensions sways the Milky Way or the system of sun-clusters. And the analogy may be extended to the systems of the fourth, fifth, and higher orders.

I cannot better close the account of Lambert's remarkable speculations than by quoting the remarks in which he describes the wonderful grandeur of the universe of systems as pictured in his theory:—"How far soever we may extend the scale," he says, "we must necessarily stop at last. And *where?* At the center of centers, at the center of creation, which I should be inclined to term the capital of the universe, inasmuch as thence originated motion of every kind, and there stands the great wheel in which work the teeth of all the rest. From thence the laws are issued which govern and uphold the universe; or rather, there they resolve themselves into one law of all others the most simple. But who would be competent to measure the space and time which all the globes, all the worlds, all the worlds of worlds, employ in revolving round that immense body—the Throne of Nature and the Footstool of the Divinity! What painter, what poet, what imagination is sufficiently exalted to describe the beauty, the magnificence, the grandeur, of this source of all that is beautiful, great, and magnificent; and from whence order and harmony flow in eternal streams through the whole bounds of the universe!"

THE SUN AND SUN SPOTS.

PROF. YOUNG, of Princeton, in a recent lecture, asks: Is there any connection between the maximums of sun spots and terrestrial disturbances of any kind? Much surmise and also much serious investigation exist on the subject. The average of their occurrence is, from maximum to maximum, either 13.11 years 100, or 9.11 years 100. Now this periodicity is not analogous to planetary action, and cannot, therefore, be caused by any planet, as was the first supposition. Mercury and Venus were suspected of being connected with the matter because they were so near the sun, and Jupiter because of its immense size, and also because the period of its orbit was nearly coincident with the cycle of the spots. But this has never been made out. It is more probable that the cause is solar, and Prof. Young conjectures that the forces in the sun accumulate and, as it were, boil over at recurring periods with the same irregular regularity as the spouting of a geyser.

It has been proved by our delicate instruments for measuring heat that a sun-spot gives only one-half as much heat as another part of the sun's surface. This was shown by Professor Langley. But he also showed that the disturbed surface as a whole gives out rather more heat than less.

It was said that in 1870 there was also a maximum of sun spots, and an extraordinarily hot summer. But it was forgotten that observations to be conclusive must cover the whole of the earth's surface, and not a part only. It so happened that in 1870 at our antipodes in New Zealand there was at the time of our hot summer an intensely cold winter, something phenomenal for that region. But an unmistakable connection has been discovered between these maxims and aberrations of the magnetic needle. It is well established that the period of a maximum of spots is coincident with a period of greatest declination of the needle. It may be that the iron in the sun has something to do with this.

Ordinarily what we see of the sun is the photosphere. But outside of that and beyond it the sun has an envelope of gas and streamers. This invisible part becomes visible at times of eclipse. Previous to 1868 a number of brilliant ruby-colored objects had been observed upon the edge of the eclipsed body of the sun. In 1868 the nature of these prominences was discovered. They were at every part of the photosphere, and there could be no doubt that there was a layer of them, which from the brilliancy of its coloring received the name of chromosphere. The spectrum showed that these were gaseous, and also that the gas was hydrogen. Janssen made the brilliant discovery that this chromosphere could be observed at any time, and that the astronomer need not wait for an eclipse to study it. Lockyer in England had found out the same thing.

Professor Hastings, now of Yale College, who accompanied the Caroline Island party for the purpose of examining the corona, came to the conclusion that the gaseous envelope that gives the bright line in the spectrum was very narrow indeed, and its apparent enlargement was due to the diffraction of light. If the light were so diffracted, the appearance of the halo would be vivid on the east side at the beginning of the eclipse and on the west side at the end. And that this is the

* More fully however in 1761. Lambert tells us that his theory was formed in 1749, when he was not 21 years old. Kant was born in 1724, four years before Lambert, but survived him 27 years, for Lambert died in 1777, Kant in 1804.

* Lambert considered that the distance between the nearest fixed star and the sun exceeds the earth's distance from the sun 500,000 times.

case is absolutely certain. Prof. Young is not prepared to go so far as Hastings, but says the latter's observations prove beyond much doubt that this atmosphere, or quasi atmosphere, is not so great in extent as had been imagined, and cannot be greater than from 25,000 to 50,000 miles.

From the examinations of the chromosphere it is obvious that the prominences are projected into something beyond it, and this action has an extraordinary resemblance to the formation of clouds in our own atmosphere. They have been seen at first low and not much beyond the chromosphere, and then in a few minutes they have rushed out beyond it, so as to produce the appearance of a prairie on fire. Then they have separated themselves from their base, like clouds forming above a river in summer, and have returned to it, like the same clouds falling in rain. There can be no question of the connection between the bright faculæ and the prominences. These prominences have assumed shapes described as clouds, as diffuse, filamentary, stemmed, as horns, plumes, spikes, sheafs and volutes, jets, vertical filaments, cyclones, eruptions, and flames.

THE GREATER MOTH ORCHID.

(Phalænopsis grandiflora.)

A FEW small-flowered Phalænopsids are met with on the continent of India, but most of the species are found in those islands of the Malayan Archipelago which cluster like so many emeralds in the warm and shallow sea near to the line. The natural focus or head center of the genus would seem to be the Philippine group, where P. amabilis and the rosy-flowered P. Schilleriana are alike at home. Here the rare P. intermedia and its rosy variety P. Portei are also found, as also P. rosea and one or two others of less note. Passing from Manila to Borneo, we find P. amabilis replaced by P. grandiflora; so also in Java by another variety of the last named species, with thicker leafage and more constitutional vigor both in growth and inflorescence. P. grandiflora is of all the kinds one of the most difficult to grow in our hothouses in a really permanent and satisfactory way.

THE GREATER MOTH ORCHID.
(Phalænopsis grandiflora.)

Why this should be so is not easily explained, seeing that they grow so readily in the orange and mango orchards of the tropics. Naturally P. grandiflora affects the coast line or the small islets so plentifully scattered in the China Sea between Borneo and Singapore. For years nearly all the plants of P. grandiflora offered for sale in Singapore were collected in the Tambelan Islands, off the southwest coast of Borneo, but this source of supply is now well nigh worked out. In 1877 a new habitat was discovered in which the plant grew very abundantly, to the north of Labuan Island, but this again is now exhausted, and collectors must look further afield. But few other epiphytal orchids evince such a decided preference for the sea. I have seen P. grandiflora growing on low trees actually hanging over the beach, and in positions where it is difficult to see how at all times it could have escaped the influence of salt spray. Perhaps want of air is what it most suffers from in our hothouses, seeing that abroad it is subjected to strong trade winds and occasional hurricanes. The robust root growth of P. grandiflora astonishes all who see the plant growing in its native habitat for the first time. How tightly the plants are lashed upon the trunk or branch on which they grow! Here, high up in mid-air and under a fierce sun, all the leaves are occasionally scorched off, or dried off by sun and wind during an exceptionally dry monsoon, but the plant's energy still lives in its roots, which, securely lashed to the bark of trees, remain firm and strong, and no sooner does the wet season arrive than leaves and flowers are produced as if by magic, so quickly do they appear. It is quite a mistake to imagine that orchids produce more flowers in our hothouses than they do in their natural habitats. Very few tropical plants ever give us a tithe of their luxuriant flower growth in our hothouses. In the case of orchids this is particularly true: not only are the blossoms more numerous and finer in color, but they are produced on growths much smaller in many cases than could ever be induced to bloom under our dull skies. The beauty of all orchids, however, in the tropics is short-lived, since wind and insects alike too soon destroy their loveliness. In this matter home growers have the advantage, since whatever flowers are produced are preserved fresh and fair for a much longer time than is possible abroad. Home growers can also induce many tropical plants to display their flowers much sooner than such plants would naturally do in their native forests or savannas; but any one who has seen Nelumbium speciosum growing and flowering in a wet ditch or canal in the East would scarcely recognize its pale blossomed representative in our gardens at home. So also of bougainvillea in its native woods; nay, even in Southern France and Italy; so also of the large flowered moth orchids, which abroad give a shower of white blossoms from a mass of spikes, old and young alike, just as shown in the annexed engraving. Neatness and trimness we secure by hothouse culture; the flowers too are preserved for us as long as is possible for them to endure when undisturbed; but there the advantage ends. We have only to look at the imported masses of Cattleyas, Odontoglossums, and Phalænop-sids, to see how true this view really is. That there are exceptions to the general rule goes without saying; but a glance at nearly all imported orchids, sturdy masses fairly bristling with stout and vigorous flower spikes, reveals Nature's own secret of tropical plant growth and of its luxuriant blossoming. That Phalænopsis grandiflora succeeds so badly as a rule in our hothouses is a pity, seeing that but few other tropical orchids surpass it in graceful beauty when, as now and then does happen, it is well grown. A specimen similar to the one we figure bearing fifty flowers and buds is a rare sight nowadays, albeit possible twenty or thirty years ago.—*B., in The Garden.*

THE DUGONG OF QUEENSLAND.*

ALTHOUGH the marine mammalia of New Zealand are well represented, its waters have produced no such treasure of the deep as the dugong (*Helicore australis*), found off the coast of Queensland. The oil of the dugong is an article of export, and its medicinal properties resemble those of cod-liver oil. The flesh of the animal is also very palatable and nutritious, and is much relished both by the natives and Europeans, hundreds of whom engage in hunting it. Some of the flesh made into bacon has been brought to New Zealadd and pronounced by epicures to be a delicacy. It is said that flesh can be procured from the same animal resembling beef, veal, and pork. The dugong is about the same size and shape as the porpoise, but, unlike the latter, has no dorsal fins. The skin is very thick, and makes excellent leather. The bones are large and of the specific gravity of ivory, and are susceptible of a very beautiful polish. The eyes, ears, and fins are small, and the tail like that of the whale. The dugong is described as a graminivorous ruminant. By means of its large lips the long blady grass, growing on the banks of the shallow water it frequents, is plucked off and conveyed to the mouth, the upper and lower parts of which are covered with circular tufts of short, bristly hair, a wise provision of nature, for without these bristles the blades of grass could not be retained in the mouth. Two tusks on the males protrude from the upper jaw. The females have tusks also, but they do not protrude. The grinders resemble those of ruminating animals, and the stomach is exactly like that of an ox. These peculiarities, together with the metallic sound of the bones, have led many to believe that the dugong is the behemoth of the Bible. The lungs of the dugong are of great length and capacity. The mammæ are beneath the fins. In rising to blow the dugging does not show as much of its body as the porpoise. The noise at a distance sounds like that of a turtle.

They not unfrequently measure from 15 to 16 feet in length, and from 10 to 12 feet round. Several specimens were recently caught off the coast of Shadbrooke Island, each of which yielded from 200 to 300 pounds of beef and from 10 to 12 gallons of oil. The skin varies from three-fourths of an inch to an inch and a quarter thick, the thickest part being on the back.

A chemist in Queensland has established, in connection with his dugong fishery a factory for preparing the oil, bacon, and lard for the market. He has been fortunate in obtaining the highest awards at the international exhibitions held at London, Paris, Philadelphia, Sydney, and Melbourne. The mode of catching the dugong is peculiar. It comes in with the tide and feeds on the submarine algæ growing on the mud flats of this coast. Nets are stretched across the deep channels leading to the flats, and the fish are entangled in them, and being unable to rise to the surface and get fresh air are literally drowned in their own element. Sometimes they are hunted like whales, with boats and harpoons. The animal when struck with the harpoon, which has a long line tied to it, is allowed to drag the boat after it until exhausted from the loss of blood. The line is then drawn in and the dugong dispatched with a razor-like lance and towed ashore.

* From report by Consul Griffin, of Auckland.

PREHISTORIC PITS IN OREGON.

A. F. JOHNSON writes to the *Oregonian* that eight miles above the mouth of the Sandy River, and about twenty-five miles from Portland, may be found what are clearly the works of a race of men other, if not more ancient, than our present Indians. At the point named the Sandy sweeps around a ridge, and traversing a distance of probably a mile and a half, describes a figure not unlike an ox bow. At the narrowest point this peninsula is about forty rods across, and at the highest point is probably two hundred feet above the level of the river. Here, at intervals of fifty feet, are a series of shafts or holes, each of which covers an area of, say, 6' x 20', and judging from the embankments formed on the sides (the dust is deposited only on the sides), must have been a dozen feet in depth. These excavations are ranged in a straight line entirely across the peninsula, and, what seems remarkable, in every case the longer axes point at right angles to the line of excavations. Just how ancient these works are it is, of course, impossible to determine, but that they existed prior to the great tornado that swept over this valley about two hundred years ago, and has left its footprints everywhere, is evident. Nor can it be that the labor necessary to the accomplishment of these works was expended by our present labor-despising Indians. But for what purpose this forgotten race toiled for so many weary days, who these ancient workers were, whence they came, when they disappeared and why—these are problems for the antiquarian which time may never solve.

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